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HOUSE-FLIES AND BLUEBOTTLES.—II.

By E. A. Butler.

As all five of the flies mentioned in our last paper belong to a single family, the *Muscidæ*, they exemplify the same structural type, and, except in a few matters of detail, one may be taken as representing all. To illustrate the main points in a fly's structure, therefore, we will select the bluebottle or blow-fly (*Calliphora*), as it is the largest of the indoor species, and can always be easily obtained. We will suppose that we have before us one of these flies, which has been killed without crushing or otherwise damaging the body; this can be done by means of the fumes of chloroform, cyanide of potassium, or crushed laurel leaves, any of which will in a few moments render such an insect insensible, while a longer exposure to the poisonous vapours will kill it entirely, and leave it in a good condition for examination.

The distinguishing feature of the order is at once noticed in the single pair of membranous wings placed horizontally over the back when at rest, and extended at right angles to the body when in use. As the Diptera are the only order of insects in which a single pair of wings is normally present, there is very little difficulty in distinguishing them, and there are very few other insects that can possibly be mistaken for them. Each wing consists of a thin double membrane, strengthened by six longitudinal hollow ribs or "nervures," of which the larger contain breathing tubes (tracheæ) and nerves. The nervures are not scattered at random, but always, as in other orders, follow a definite course, which varies somewhat in different genera or even species, but is constant in the same, and the general plan is sufficiently definite to permit of the individual nervures being identified and named, so as to be used as aids in classification. A comparison of the accompanying drawing of a bluebottle's wing (Fig. 2) with

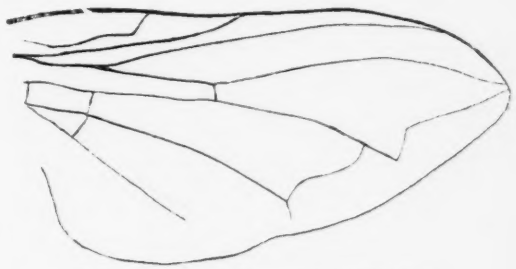

Fig. 2.—Wing of Bluebottle (*Calliphora*).

those of the larger and smaller house-flies given in our last number, will further show what sort of differences may be expected in this respect. The present plan is very much like that of the house-fly proper, and the chief difference is in the præbrachial nervure (the third on the disc of the wing towards the tip); in the present species it will be found first to bend at right angles towards the nervure above it, and then to slope towards the margin, while the little cross nervure (discal transverse) which joins it to the next below, meets it very much nearer its upward bend than in *Musca domestica*. The front edge of the wing is bounded by the strongest of all the nervures, the costal, which is furnished, towards the base, with a row of short bristles. To the naked eye the wing appears to consist only of membrane and to have no clothing of any kind; but microscopic examination shows a multitude of extremely minute hairs distributed all over its surface, but very evenly and regularly disposed. There are also larger hairs on the nervures, which may perhaps be sensory in function.

The wings can be vibrated with marvellous rapidity, sufficiently so to produce a recognisable musical note. Attempts have been made to determine the number of vibrations per second by observing the pitch of the note. The usual pitch of a fly's hum is somewhere about the notes E or F, and the corresponding number of vibrations would be something between 320 and 350. The characteristic *buzzing* of our bluebottle, however, is not due to the vibration of the wings, nor, like the shrill song of the grasshopper, or the squeak of the water-beetle, to the friction of one part of the body against another; for Landois discovered that the thorax of a bluebottle continued to buzz with scarcely diminished vigour after the separation of the wings, legs, head, and abdomen. There is also a large and beautiful yellow-banded fly, called *Sericomyia borealis*, not uncommon in our mountainous districts, which has by several observers been noticed to "sing" whilst at *rest*. The Rev. J. Hellins, of Exeter, thus writes of it in Dec. 1881: "One day during the past autumn I went with a small party for a walk on Dartmoor, near Okehampton; after some miles of rough tramp up and down several tors, as the afternoon was drawing on, we found ourselves on a heap of stones on the top of Cawsand, and were glad to rest there awhile; before long, a piping sound was audible, and one of the party said the wind was whistling; but to this explanation I demurred, having some recollection of having heard the noise before; so, looking round, I soon saw several large flies resting on the stones, and was presently able to convince my friend that the sound came from them." In the case of the bluebottle, at least, and also probably in that of the other fly as well, the sound-

producing organ is connected with the thoracic spiracles, or breathing apertures, and the harsh and stridulating character of the sound suggests what appears to be really the case, that it is caused by the vibrations of hard solid bodies. A hemispherical cavity intervenes between the spiracle and the main tracheal trunk, and in this are situated some hard chitinous processes, by the vibrations of which it is believed that the sound is produced.

Closely connected with the remarkable power of the wings is the peculiar development of the thorax, which is so characteristic of the Diptera. Roughly we speak, with reference to insects in general, of the second apparent division of the body as the thorax; but it by no means follows that the part occupying that position and most distinctly visible when viewed from above, is homologically the same in all cases. The complete thorax is composed of three segments called respectively pro-, meso-, and meta-thorax; but in the more highly specialised groups of insects these three are not equally developed, and sometimes it is one, sometimes another of the three parts, the development of which on the upper surface preponderates over that of the rest. Thus in the Coleoptera (Beetles) and Hemiptera (Bugs), what is frequently called the thorax, on the dorsal view, is in reality only the prothorax; in the Hymenoptera (Bees, &c.) it consists mainly of both meso- and metathorax, and in the Diptera almost entirely of the mesothorax. This is the division to which the fore-wings of all insects are attached; and as in the Diptera this is the only pair of wings that is developed as such, the peculiar conformation of the thorax of a fly finds herein an explanation. The chief thoracic muscles are not attached to the wings themselves, but run from one part of the walls of the thorax across to the opposite wall, so that the greater part of the vibration of the wings is produced by alternating changes in the shape of the thorax.

At the base of each wing is a double membranous scale, the "*alula*" or "winglet" (Fig. 3); each of its divisions

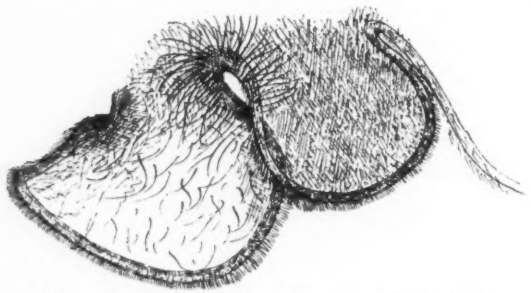

Fig. 3.—Right Winglet of Bluebottle (*Calliphora*).

has a rounded and thickened outer edge, and the membrane is extremely closely covered with minute hairs similar to those on the wings, the larger part having in addition some long flexible hairs arranged pretty regularly but not closely in rows. The free edge of each is also very closely fringed with delicate hairs. When the wings are stretched out for flight, these scales form a continuation of their area as far as the centre of the hind margin of the thorax. Hence the inner scale has, as shown in the accompanying figure, a sloping edge where it fits under the side of the triangular termination of the thorax. But when the wings are closed, the outer scale is folded over the inner along their line of junction, as well as under the wing itself, so that they lie one upon another like the leaves of a book. It is impossible to say what is the significance of these *alulæ*; though connected with the wings, they can hardly have much influence upon flight, and the peculiar arrangement of the double fold, together with the remarkable profusion of hairs, seems to suggest some other function. They reach their highest development in the family *Muscidæ*.

A little distance beneath the larger fold of each *alula*, and entirely overarched and concealed by it, is an organ (Fig. 4) which is highly characteristic of flies; it consists of a slender stalk carrying a globular expansion at its outer end, and near the point of attachment of the stalk to the thorax are three minute sets of rows of papillæ with hairs. These stalked globes are called *halteres*, balancers, or poisers; they are most conspicuous in such flies as the daddy long-legs, or crane-flies, and in the bluebottle are reduced to extremely small dimensions, so that they are not likely to be noticed at all unless carefully looked for. It is curious that the development of the *alulæ* is always in inverse proportion to that of the *halteres*. Though so minute, their structure is sufficiently elaborate to suggest that they must be of considerable importance in the economy of the insect; and many different functions have been, more or less conjecturally, assigned to them. Their names, as above, indicate a notion once current that they helped the insect to maintain its equilibrium during flight; they have, again, been considered to be organs of hearing, or to be in some way connected with respiration. Situated as they are on the metathorax, they appear to be the representatives of hind wings.

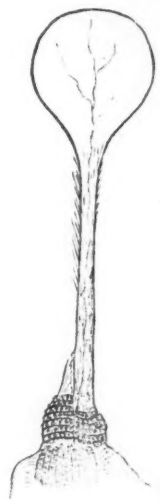

Fig. 4.—Balancer of Bluebottle (*Calliphora*). Showing Basal Papillæ and Nerve.

The legs of the bluebottle consist of the usual parts, and there is nothing of special interest or importance till we come to the feet. All the tarsi consist of five joints each, and are terminated by a pair of curved claws, under each of which is placed a fleshy pad fringed with hairs, and between the pads is a straight sharp-pointed spine. In these pads, or "pulvilli," as they are called, lies the secret of the power flies possess of running over surfaces in any position, often in defiance of gravity. A fly finds no more difficulty in running up or down a vertical window-pane, or across a ceiling, than in walking over a perfectly horizontal surface. This is not the case with all insects, many of which would struggle in vain to mount a perpendicular glass surface; hence it cannot depend entirely upon the claws, for these are developed in all insects, and would therefore give all equal facilities; no doubt the claws are of some help when the surface is at all irregular, as, for example, on a ceiling; but they can hardly be of much use in travelling over glass. We therefore look to the pulvilli for the explanation. It was at one time supposed that their efficiency depended upon atmospheric pressure, and that they acted like suckers, the edges being closely applied to the surface, and the centre part pulled up so as to create a vacuum beneath. This explanation, however, seems to be negatived partly by the absence of any mechanism to produce such a vacuum, and partly by the presence of great numbers of minute hairs on the under surface, which could hardly do otherwise than interfere with such a close application of the edges of the pad to the surface as is required by the hypothesis. The mechanism which brings about these curious results must rather be sought for in the hairs

themselves. The pads are, in fact, hollow and contain protruding into their cavity the nipple-shaped ends of a sac which occupies more or less of the interior of the last four tarsal joints. This sac secretes a perfectly clear, viscid liquid, which exudes into the pad, and from that into the hairs which project from it. These hairs, which are said to number about 1,200 on each pad, are hollow, terminate in tubular orifices, and are kept full of the secretion. Hence the entire surface of each pad is crowded with a number of viscid points; and as there are in all twelve pads, two to each foot, these, when applied to the surface over which the fly is walking produce an adhesion sufficiently strong to support the slight weight of the insect. The viscid liquid soon hardens on exposure to the air, but no doubt remains liquid while covered by the pad. Thus the insect is, as it were, at every step, temporarily glued to the surface over which it is travelling, and leaves on a clean surface little rows of dots as its footprints. This does not necessarily involve any violent strain in wrenching the foot off again, since the tarsus is raised obliquely and each row of hairs is therefore successively detached, somewhat in the same way as a piece of court plaster may be easily removed from the hand by taking it up at one end and raising it obliquely, though it might resist a considerably greater strain if merely pulled at one end without raising, all the points of contact then combining to resist the strain.

(To be continued.)

HINDU ARITHMETIC.

By Frederic Pincott, M.R.A.S.

EUROPEANS who have resided in India have frequently expressed astonishment at the rapidity with which arithmetical calculations are mentally made by very small Indian boys. Some account, therefore, of the Indian method of teaching arithmetic, which I believe to be superior to the English methods, will probably be interesting to the readers of Knowledge.

The arithmetical system of Europe was revolutionized by India, when the so-called Arabic figures which we daily use were borrowed by Arab traders to the Malabar coast, and by them introduced into Europe. It was Indian intelligence which devised the method of changing the values of the numeral symbols according to their positions. This ingenious conception rapidly superseded the older methods, and gave enormously increased facility to arithmetical computations as compared with the Greek and Roman and the older Arabic methods.

In order to explain the present Indian system of arithmetic, it is necessary to premise that the *Pándhes*, or schoolmasters, employ a number of terms unknown to English teachers. These terms have been invented for the purpose of facilitating calculation, and the astonishing results achieved cannot be understood without comprehending the terms employed. The strangeness of the names of the figures and fractions arrests the attention of every student of Hindi. Few Europeans attempt to master the fractions; and there are some who, after many years residence in India, cannot repeat even the numbers from one to a hundred.

Indians use monosyllables similar to ours, from 1 to 10; but from that point the words are built on the model of "1 and 10," "2 and 10," "3 and 10," &c.,* up to "8 and 10," but the word for 19 means "minus 20." After 20 the same method is continued; "twenty-one" being impossible, the form is invariably "1 and 20," "2 and 20," up to "minus 30," "30," "1 and 30," and so on. This method of nomenclature goes back to remote antiquity; for the old Sanskrit language presents the same peculiarity.† The object of this nomenclature is to facilitate computation; for, in reckoning, the mind has to deal with the even tens, the simplest of all figures to multiply. Thus the question "Nine times nineteen?" is not a simple one to an English child; but the Indian boy would be asked "Nine minus-twenties?" In an instant he knows that he has only to deduct 9 minus quantities from 9 twenties, and the answer 171 comes before the English boy has fully realized the question. The formidable difficulty of the 9 is thus completely got rid of by a mere improvement in nomenclature.

Another advantage that the Indian boy has is the use of short, mostly monosyllabic, terms for every ascent in the decimal scale; thus such lumbering expressions as "one hundred thousand" are unknown to him, the simple word *lâkh* conveying the idea fully to his mind. So also "one thousand millions" is *arb*; "one hundred thousand millions" is *kharb*, and so on. The advantages of this terseness must be at once apparent.

It is, however, with respect to fractional numbers that the advantage of the Indian system of nomenclature becomes most conspicuous, when once understood. They employ a large number of terms, which are given below.‡

These terms are *prefixed* when used in combination with whole numbers, the object being to present the special modification to the mind before the number itself is named. Complicated as this nomenclature appears at first sight, its difficulties disappear when brought to the test of practice. It is the outcome of centuries of practical experience; and the thoughtful application of means to an end. It will be sufficient to illustrate the use of these words, and the extraordinary arithmetical facilities they afford, if I explain the use of *paune*, that is $\frac{3}{4}$, that being the fraction which the English child has most trouble with. The Indian boy knows no such expression as "two and three-quarters," in fact the term "three-quarters" in combination with whole numbers, has no existence in his language. His teacher resorts to the same device as has been explained when speaking of the figure 9; he employs a term which implies "minus." By this process $2\frac{3}{4}$ becomes *paune tîn*, that is "minus 3," or "a quarter less 3," and, in the same way, $3\frac{3}{4}$ is *paune châr*="minus 4," and so on.

Precisely the same plan is adopted with reference to the term *sawâ*, which implies "one quarter more"; thus $3\frac{1}{4}$ is *sawâ tîn*="plus 3"; $4\frac{1}{4}$ is *sawâ châr*="plus 4," &c. &c. It will now be seen that the *whole* numbers form centres of triplets, having a minus modification on one side, and a plus modification on the other. This peculiar nomenclature will be clearly apprehended by the following arrangement:—

$2\frac{3}{4}$	paune-tîn -3	$3\frac{3}{4}$	paune-châr -4	$4\frac{3}{4}$	paune-pânch -5
3	tîn 3	4	châr 4	5	pânch 5
$3\frac{1}{4}$	sawâ-tîn $+3$	$4\frac{1}{4}$	sawâ-châr $+4$	$5\frac{1}{4}$	sawâ-pânch $+5$

In multiplying these fractions, therefore, the Indian

* This is also the original meaning of the English words *eleven*, *twelve*, &c., up to *nineteen*.

† In the ancient language there was also an optional form in conformity with the English method.

‡ Pâ,o $=\frac{1}{4}$; âdh $=\frac{1}{2}$; paun $=\frac{3}{4}$; paune $=-\frac{1}{4}$ ($\frac{1}{4}$ less than any number to which it is prefixed); sawâ $=1\frac{1}{4}$ ($\frac{1}{4}$ more than any number to which it is prefixed); sârhe $=+\frac{1}{2}$ ($\frac{1}{2}$ more than any number to which it is prefixed); derh$=1\frac{1}{2}$ (a number+half itself); pawannâ $=1\frac{3}{4}$; aṛhâ,i $=2\frac{1}{2}$ (twice and a half times any number); hûṅṭhâ $=3\frac{1}{2}$; ḍhauńchâ $=4\frac{1}{2}$; pahûńchâ $=5\frac{1}{4}$.

XUM

boy has to deal with only the minus and plus quantities. A simple instance will illustrate this. "Seven times ninety-nine and three-quarters?" would be a puzzle to an English child, both on account of its lumbering phraseology, and the defective arithmetical process he is taught to employ. The Indian boy would be asked, "*sât paune-sau*?" three words meaning "seven minus-hundreds?" The very form of the question tells him that he has only to deduct seven quarters from 700, and he instantly answers $698\frac{1}{4}$. Equal facility is found with any similar question, such as "five times fourteen and three-quarters." The Indian boy is asked, "pânch paune-pandrah?" *i.e.* "five – 15's?" As the words are uttered he knows that he has only to deduct 5 quarters from 5 fifteens, and he answers at once "paune chau-hattrah," *i.e.* "a quarter less four-and-seventy" ($73\frac{3}{4}$).

So much for the machinery with which the Indian boy works. The more it is understood, the more it will be appreciated. It is, undoubtedly, strange to English preconceptions; but it would be a real blessing to our country if corresponding suitable terms were invented, and this admirable system were introduced into all our schools.

Some Europeans have sought to account for the surprising results attained by Indian children, by attributing them to special mental development due to ages of oral construction. It is perfectly true that Indians rely more on their memories than on artificial reminders, and no one can come into contact with the people without being struck by their capacity for remembering. It is well known that many of the ablest men the country has produced could neither read nor write; but they hardly missed those accomplishments, for their minds were frequently stored with more information, which was more ready to their command, than that possessed by the majority of book-students. It is well known that Ranjît Singh could neither read nor write, but he knew all that was going on in every part of a kingdom as large as France. He was an able financier, and knew at all times accurately the contents of all his treasuries, the capacities of his large and varied provinces, the natures of all tenures, the relative power of his neighbours, the strength and weakness of the English, and was, in all respects, a first-class administrator. We commit the mistake of thinking that the means to knowledge is knowledge itself. This induces us to give all the honour and prizes to reading and writing, and leads us to despise people—whatever their real attainments may be—who have not acquired the knack of putting their information on paper. It ought to modify our opinion on this point to reflect that the architectural triumphs of India were nearly all built by men who could neither read nor write. Another illustration of dependence upon memory instead of paper can be found in the Indian druggist, who will have hundreds of jars, one above another, from floor to ceiling, not one of them marked by label or ticket, yet he never hesitates in placing his hand on the right vessel whenever a drug is required. The same, to us, phenomenal power of memory is shown by the ordinary washermen, who go round to houses with their donkeys, and collect the clothes, some from one house, some from another. These they convey to the river and wash, and in returning with the huge pile, never fail to deliver each particular article to its rightful owner.

The Indian boy's first task is necessarily to commit to memory the names of the figures from 1 to 100. He is next taught that there are nineteen places for figures, and their names. These correspond to our units, tens, hundreds, &c.; but the monosyllabic curtness in the names of the higher numbers is his distinct advantage.

What we call the multiplication table then begins. In England the multiplier remains constant, and the multiplicand changes; thus, children repeat "twice one two; twice two four; twice three six," &c. &c. In India the boy is taught to say "one two, two; two twos, four; three twos, six," &c., his multiplier changing, while the multiplicand remains fixed. Another peculiarity is this, he begins at 1, not at 2; and this furnishes him with a series of most useful collective numbers. Here, again, the English language lacks terms to translate the first table, but an idea may be gained from the following attempt:—

One unity	one
One couplet	two
One triplet	three
One quadrat...	four
One pentad	five
&c.	&c.

These names for aggregates, as distinguished from mere numerals, are of much value to the boy in the subsequent processes, and give him another distinct advantage over the English lad.

In learning these tables the boy is not carried beyond 10, that is, he goes no further than "two tens, twenty," "three tens, thirty," &c.; but to make up for that forbearance he is carried on in this process of multiplying figure by figure not only to 12, or (as is sometimes done in England) up to 20, but he goes on through the thirties, and does not make his first halt until he gets to "ten forties, four-hundred." In achieving this result something more than mere memory is brought into play, for he is taught to assist his memory by reference from one table to another, thus the first half of the six table is contained in the three table, &c.

A short supplementary table is next taught beginning at 11×11 to 20×11 and then proceeding to 11×12 to 20×12, and so on up to 20×20. This method reduces considerably the tax on the memory; for one half of the table is obviously the same as the other half, and therefore only half calls for special effort.

The boy has now committed to memory the multiplication of every figure from 1×1 to 20×20, and in addition he knows the multiplication of every figure up to 40 by the ten "digits." It will be observed that both tables end at 400 (10×40 and 20×20); in fact, 4 is the most important factor in Hindu arithmetic, all figures and fractions being built upon multiples and fractions of it.

At this point, instead of practising on imaginary sums in the hope of learning arithmetic empirically, the Indian lad immediately proceeds to tables of fractions, the first being the multiplication of every figure from 1 to 100 by $\frac{3}{4}$. Here, again, according to English ideas, $\frac{3}{4}$ would be the last fraction we should attempt; but in India it is the first, and, by the superior system of nomenclature there in use, it is a very easy affair. The boy, knowing the multiplication of the whole numbers, is taught to deduct the half of the half ($\frac{1}{4}$), and the thing is done. Memory is assisted by observing that every multiple of 4 is a whole number, and that the number below it will always be a *sawâ* of the next lower figure, and the number above it always a *paune* of the next higher figure. Thus in answer to the question $\frac{3}{4} \times 36$ the Indian boy says mentally, 18, 9, 27; he also knows that 36 is the 9th multiple of 4, and by immediately deducting 9 can get his 27 that way also. Knowing, also, that 36 is a multiple of a 4 yielding 27, he knows that 35 will yield *sawâ chhabbîs* ($26\frac{1}{4}$); and that 37 will yield *paune aṭhâ,îs* ($-28 = 27\frac{3}{4}$). In this way three-fourths of the table is a matter of logical necessity, resting on the elementary table previously acquired.

In the next table the boy is taught to multiply every

figure from 1 to 100 by $1\frac{1}{4}$. This, of course, is precisely the reverse of the last; the $\frac{1}{4}$ is ascertained and added, instead of being deducted. Here again the multiples of 4 are whole numbers; but the figures preceding result this time in a *paune*, and those next following in a *sawâ*. This table also costs but little effort when thus taught.

The next table teaches the boy to multiply from 1 to 100 by $1\frac{1}{2}$, and, of course, means simply adding half the multiplier to the figure itself.

The next step, multiplying from 1 to 100 by $1\frac{3}{4}$, is achieved by simply adding three-quarters of the multiplier to the multiplier itself. The "three-quarters" table has been already acquired by the boy, and he has therefore only to add any given multiplier to it. Thus, if asked, "What is 27 times $1\frac{3}{4}$?" he knows that 27 *paunes* are $20\frac{1}{4}$; he has, therefore, only to add this to the 27 itself, to get $47\frac{1}{4}$ as the instant answer.

The boy is next exercised in multiplying 1 to 100 by $2\frac{1}{2}$, and he is taught to do this by adding half the multiplier to the "twice-times" table.

Then follow similar tables multiplying by $3\frac{1}{2}$, $4\frac{1}{2}$, and $5\frac{1}{2}$, and the results are arrived at instantaneously by adding to the "three-times," "four-times," and "five-times" tables half the multiplier in every case.

In all these tables the rapidity and simplicity is in great part due to the terms employed. The boy is not asked to "multiply seventeen by three-and-a-half," or "What is three-and-a-half times seventeen?" or puzzled by any other form of clumsy verbosity. The terms he uses allow him to be asked "*sattrah hûnṭhe?*" (seventeen three-and-a-halfs). His elementary table has taught him that $17 \times 3 = 51$, and he knows that he has only to add half 17 to that, and the sum is done.

The final task of the Indian boy is a money table, which deals with a coinage which may be thus summarised:—

16 damṛî = 1 ṭakâ.
16 ṭake = 1 ânâ.
16 âne = 1 rûpî.

There is a small coin called *dâm*, three of which make 1 *damṛî*; and, therefore, 48 make 1 *ṭakâ*, and 96 = *ânâ*, 4^2 being still the unit. The table imparts a familiarity in combining these coins together.

This completes an Indian boy's most elementary course of arithmetic, and a little reflection on the great facility for computation which Indian children show, and the simplicity of the means by which it is effected, ought to make us rather ashamed than boastful of our own defective methods. The insolence of ignorance has induced us to despise the Indian method, and to endeavour to introduce into India our own miserable muddle. The proportion of our success in this attempt will be the measure of India's misfortune. It would be far wiser to endeavour to understand a subject before we condemn it, and, in the present instance, it would be well if suitable terms could be adopted which would allow the admirable system of Indian *Pândhes* to be introduced into English schools.

WALKS IN THE SYDNEY BOTANIC GARDENS.

By C. Parkinson, F.G.S.

(Continued from page 74.)

Among the numberless species of fig in the Sydney gardens there is none more attractive than the sacred fig (*F. religiosa*), a specimen of which Tennent describes at Kandy as the most ancient existing tree in all the world. It is instructive to note how exotic plants—known to us in England under glass, and in dwarfed condition only—here fall naturally into their respective orders. An example of this I saw in the india-rubber plant (*Ficus elastica*), growing as a tree in the sub-tropical gardens; at home few recognise in the broad leaves a species of fig. This occurs in a hundred cases.

Without actual experience it is hard to form any conception of the intense brilliancy of the foliage plants, whole beds of which enliven the terraces. The variegated croton has mottled leaves of all tints. Mr. Moore, the Curator, led me to one bed—his special pride—a very blaze of delicate crimson, from seedlings of the amaranthus tricolor, a miniature forest resplendent in the clear atmosphere and bright light of the South Pacific. The fresh tender shoots looked on fire in the dazzling mid-day sun, and in the evening all the leaves became comparatively dull. Close to these beds there was a trellis-covered way—a bower of creeping plants, roses, passion fruit, with red, yellow and blue trumpet-flowers (*Bignonia*)—leading to the aviary. Among the caged birds I found the stupid-looking wood-hen from Lord Howe's Island, evidently akin to the wingless apterix of New Zealand. The Australian native companion was there, with long legs, bluish feathers, and crane-shaped bill. It has enormous power in the lower extremities, stamping on rats and such vermin food with blind passion. Near to the aviary two gorgeous trees covered with rich blossom excite the admiration of all comers. One is the jacaranda, of Brazil, and the other a member of the loosestrife family, from Java, the *Lagerstræmia indica*, with heavy masses of purple-rose flowers.

At the point where the old and more recent gardens join, a pair of Norfolk Island pines (*Araucaria excelsa*) tower upwards, straight as a dart, a hundred feet or more. Between forty and fifty years old, they represent the earliest trees planted *in situ*, and are noble specimens of the fine conifer. The peculiar beauty of this araucaria is, I think, derived from the branching pinnæ pointing upwards; but *A. Cookii*, if well developed, has a more perfect shape, and the "monkey-puzzle" like *Araucaria Bidwillii*, the bunya-bunya pine of Queensland, is a shapely tree. The latter for some reason grows far better in Melbourne than in Sydney, while the converse is the case with regard to the Norfolk Island pine.

I spent a pleasant morning with the director examining the different spices, &c., gently browsing—so to speak—on strongly flavoured leaves, with a view to detecting their identity. The cinnamon bark no one could mistake, but other kinds are not so readily distinguished. In my ignorance I had thought allspice was a blended product of the cook's spice-box. I was, therefore, surprised to find the specific tree, and fairly puzzled with the mixture of flavours which obviously gives the name to the plant. Hard by the camphor laurel grew, strong with essential oil. Tea plants from India and China stood side by side, and coffee, in both flower and fruit, from Ceylon. Although the berry is produced in Australia, the active properties are lost, and the plant is valueless except as a botanical specimen. The crimson, yellow, and orange canna, of the arrow-root tribe, remains in full flower for many months of the year, and is consequently much used throughout the garden, and the various coloured bouvardia of Japan, appears equally hardy and prolific—a plant of which stove-house specimens give a very humble idea.

At a sudden turn I came upon a most charming nook. In the foreground there was a still pool, in which the graceful Egyptian papyrus flourished. A monument to Allan Cunningham, explorer and botanist, stood half hidden in a tropical forest glade behind, where feathery palms, tree ferns, and the like, grew in delightful confu-

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sion. It is strange how different trees influence each other in degree of growth when massed together. A slow-growing palm had been developed in half the usual time by the attraction of loftier palms and tree ferns.

Many interesting cycadaceous plants were grouped in a separate bed. Of this order the macrozamia, of New South Wales, supplies an undoubted link, although degenerate with the palæontological remains from the Purbeck beds. The leaves grow almost from the ground without a trunk, like so many fronds, and are simply pinnate; but I saw a rare species with bifurcating pinnæ. The large date palm (*Phœnix*) was in fruit, with the cocoa-nut (*Cocos flexuosa*), and a magnificent specimen of *Jubæa spectabilis* from Chili. The dwarf fan palm (*Chamærops humilis*) looked very insignificant by the side of so many giants from Brazil, China, Jamaica, the East Indies, Mauritius, New Caledonia, and East Asia. A Queensland palm, *Calamus Australis*, is called the "lawyer tree," because the long, thorny appendages lurking in the bush tear the traveller's flesh; and if once they hook on, are difficult to detach. The distribution of palms in Australasia is irregular. In North Queensland, of course, the greater number are found, being nearer to the tropics. Cabbage-tree creek, in Victoria, is the only habitat for palms in that colony, and it is curious to find this isolated patch severed from all relations. New South Wales, with 800 miles of coastline, has but four species. New Zealand has, I believe, but two palms, including the Areca, notwithstanding the hot climate of the north island. Lord Howe's Island, oddly enough, has four indigenous and peculiar species, and Norfolk Island boasts of two. In New Guinea, I suspect, palms and many plants remain to be discovered. The palmæ of the world appear to thrive in the Sydney gardens, but I saw none more beautiful for horticultural purposes than the glaucous-leaved variety of the Phœnix, one of the treasures of the collection. Then I passed on to the screw-pine (*Pandanus*), with groves of banana, plantain, gaudy-flowered strelitzia, and the far-famed traveller's tree, which, to the unaccustomed eye, is singularly like a banana; it has a refreshing fluid contained in the stem. Typical bromeliaceæ form an undergrowth of ugly crowns; the opuntia, with great yellow flowers, runs riot where it will.

To those who know only the British herbaceous weeds of the Spurge tribe, the size and great variation in the *Euphorbiaceæ* is wonderful. The croton and poinsettia, already mentioned, belong to the order. The cactus-like *Euphorbia grandicornis* is widely different from the handsome drooping tree, *Excæaria parvifolia* (gutta-percha). Nearly all have poisonous juices, and the South Sea islanders steep their spears and arrows in some fatal plant of the order; even the tapioca species is deadly until the virulent juices have been extracted. It is dangerous to touch unknown plants in a tropical garden. The great nettle tree (*Laportea gigas*) produces violent irritation, exceedingly painful for many hours. I have heard that the bark of the same tree affords an antidote, but had no inclination to test the truth of the assertion. The false pepper tree (*Schinus molle*), with finely-cut foliage and coral berries, has an exceedingly pungent taste, quickly bringing tears to the eyes. I saw a species of rhus which it is dangerous for many persons to approach. Mr. Moore himself had a narrow escape, some years ago, with this plant. After an examination of the leaves, he inadvertently rubbed his eyes. Next day his features were almost obliterated by intense swelling, which gradually passed down the body to the extremities; life, for a long time, was in jeopardy, and a photograph, taken by an officer of the ship when the malady was at its worst, shows the swollen face with simply a large slit for a mouth; no eyes or nose to be seen. The case was reported in the *Lancet* at the time, and the dangerous properties of the plant are now fully recognised. Even contact is not always necessary to produce the unpleasant symptoms, as many have found to their cost.

That solid grass (*Saccharum officinarum*), more commonly known as the sugar cane, finds a place in the gardens, together with a plant much cultivated in Australia for its sweet properties, *Sorghum saccharatum*, which, with improved crushing machinery may yet be extensively used in the sugar industry. At present I think cattle are fed on what is grown.

The Acacia order is largely represented by the native wattles, and going farther afield, by the minute-leaved Peruvian inga, with feathery crimson flowers—a kindred species has tufts of white flowers like bog-cotton, which expand only at night. English oaks are scattered here and there, but nearly all grow pipe-stemmed. Possibly until they learn to shed the leaves and bark at the right season, and adapt the foliage to the changed influences of light, the timber will never grow round. After the Norfolk Island pine the most perfect tree in the garden is the *Grevillea robusta*, a proteaceous species, with leaves which reminded me of a gardener's hybrid in the south-west of England—the oak-leaved beech. The next is a coniferous plant from Mexico, known as "Montezuma's tree," from the fact that under one of them that unfortunate potentate signed his abdication. It has close, finely-cut pinnæ, almost like the inga leaves.

There are no mangrove swamps near the Botanic Gardens, but a few miles up the Parramatta they can be seen, islets in mid-stream, flooded and inaccessible. The beautiful white-faced heron, a medium-sized bird with blue feathers and red legs, breeds here in perfect safety, for approach is difficult.

The climbing rata of New Zealand, one of the most brilliant flowers of those islands, grows in an uncertain manner at Sydney. The slender stem is rooted to the ground, but frequently the seeds lurk in crevices of the supporting tree, developing a fresh plant, and finally choking the accommodating host; it is *not*, however, a parasite.

The epiphyte ferns, as opposed to true parasites, are worthy of notice, both for curious structure and gigantic size; they hang to the trunks of trees like green-brown baskets. Two kinds are natives of Australia: the stag-horn (*Platycerium grande*) I have seen, *weighing a ton*; the elkhorn (*P. alicorne*) is much smaller in bulk.

In another direction, fresh collections of ornamental shrubs border the paths: a justicia with handsome labiate-looking clusters of mottled flowers; scarlet coral trees (*Erythrinæ*); gardenia; and the fragrant tabernæmontana of Ceylon, having irregular corollas with waxy white flowers. There were also the native Christmas tree, and flaming sterculia, from Queensland. An order we in England know little about, except from the evergreen ivy, is largely distributed in the islands of the Southern Ocean—the Araliaceæ. It includes widely different genera such as the panax, having prolonged, coriaceous leaves, like the defensive weapon of a sword-fish, and the aralia with deeply cut, digitate foliage, similar to a horse-chestnut. It is a great advantage to find beneath each plant a label clearly inscribed with scientific name, authority, order, habitat, and local name; all of which, if Botanic Gardens are to be of educational value, are absolutely necessary. A space is set apart for a typical collection of plants, illustrative of Exogenous and Endo-

genous classes, and some effort has been made to group plants of medicinal value; while fibres and economic vegetable products are in the museum.

FLYING DRAGONS.

By R. Lydekker, B.A.Cantab.

LEGENDS of Flying Dragons were rife both among the ancients and also during the middle ages, but it was reserved for the great founder of the science of comparative anatomy—the illustrious Cuvier—to show that such creatures had really once existed, and were not merely the dreams of the poet and the herald. Thus in the year 1784 one Collini described the skeleton of an animal found in the fine-grained limestones of Bavaria, so extensively quarried for the use of the lithographer, which he regarded as indicating an unknown marine animal. When, however, this curious specimen came into the hands of Cuvier, about the year 1809, he at once recognised it as the remains of a reptile endowed with the power of flight, for which he proposed the name of Pterodactyle; the name being compounded from the Greek words for a wing and a finger. In thus proving, once for all, the former existence of veritable Flying Dragons it must not, however, be supposed that Cuvier thereby authenticated the old legends which represented these creatures as capturing human beings, and being themselves in turn destroyed by valiant champions. These real Flying Dragons, on the contrary, existed long ages before man or any of the higher types of mammals had made their appearance on the globe; being, indeed, characteristic of the so-called Secondary epoch of the geologists, the relations of which to the present epoch we have endeavoured to indicate in the article on Fish Lizards which appeared in Knowledge for November last.

Before the master mind of Cuvier indicated the true affinities of the original specimen of the Pterodactyle, one naturalist had regarded it as a bird, and another as a bat, and it will therefore be interesting to glance at the chief features in the bony anatomy of these creatures, to see how the great anatomist was justified in his conclusions. For this purpose we give a figure in the accompanying woodcut of the skeleton of a small Pterodactyle obtained from the Lithographic limestones of Bavaria, and remarkable for its beautiful state of preservation. It will be seen from this figure that the neck of these creatures is comparatively short, and has but few joints, or vertebræ, in which respect it is unlike that of a bird. The skull is, however, wonderfully bird-like in the figured specimen, although in some species it is much shorter and more lizard-like. There are, however, certain features in the structure of the skull, into the consideration of which it would be difficult to enter in the present article, by which it is at once distinguished from the skull of a bird. The presence of a number of sharply pointed teeth (shown in Fig. 2) was, indeed, at one period regarded as another point in which Pterodactyles differed from birds; but it has been subsequently found that many if not all the birds of the Secondary epoch were provided with teeth, while in some Pterodactyles those organs were wanting, as shown in Fig. 3. The most ready means of distinguishing a Pterodactyle from a bird is, however, to be found in the structure of the fore-limb. Thus it will be seen from Fig. 1 that the "hand" of a Pterodactyle carries three fingers furnished with claws, and a fourth extremely elongated finger which has no terminal claw, and supports the membranous wings. It is, on the whole probable that this elongated finger corresponds to the little finger of the human hand, the thumb being probably represented by the small splint-like bone seen at the wrist in Fig. 1; and in any case the finger in question is the outermost one, whether it correspond to the ring-finger or the little finger of the human hand. Now in the wing of a bird, on the contrary, neither of the bones corresponding to the fingers are greatly elongated, while the longest of these modified fingers is the one representing the index or fore-finger of the human hand, and is, therefore, the very opposite of the elongated finger of the Flying Dragons. This essential difference between the structure of the wing of a Pterodactyle and that of a bird is of such radical importance as

Fig. 1.—The Skeleton of a Small Pterodactyle, from the Lithographic Limestones of Bavaria. The creature is lying on its back, with the head bent to the left side. *a* indicates the left pubic bone; the haunch bone, or ilium, being shown on the opposite side. (After Von Meyer.)

to indicate that the Flying Dragons could not possibly have been the ancestors of birds; which (always assuming that we are right in regarding evolution as the true explanation of the mutual relation of the different groups of animals) were more probably descended from those extraordinary extinct reptiles commonly known as Dinosaurs.

The shield-like bone seen in Fig. 1, lying in the middle of the chest in front of the back-bone, corresponds to the breast-bone of a bird, and, like that of the majority of birds, has a keel projecting in front for the support of the strong muscles of the breast necessary to move the wing in flight. This remarkable similarity between the breast-bone of a Pterodactyle and that of a bird is a good instance of what comparative anatomists term an adaptive resemblance; that is, a resemblance caused by the circumstance that a particular organ or bone has to subserve the same purpose in two particular instances. It will further be observed from the figure that the skeleton of the Pterodactyle differs from that of an ordinary bird by the absence of the so-called "merry-thought" or furculum. Since,

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however, that bone is either rudimentary or absent in the flightless birds allied to the ostrich, it cannot be regarded as a feature of first rank in distinguishing Pterodactyles from birds.

Having thus shown that our Flying Dragons cannot be classed with birds, it remains to mention why they should be placed with reptiles rather than with mammals. This point is, however, at once decided by the circumstance that the skull is jointed to the back-bone by a single knob-like articulation, or condyle, instead of by the two condyles found in all mammals. If further proof were wanting, it is found in the circumstance that each half of the lower jaw consists of several totally distinct bones, as in all birds and reptiles; whereas in mammals it is composed of but a single piece.

With this glance at the general features of the skeleton of the Flying Dragons, we may proceed to notice some of the peculiarities of the different kinds of these creatures, and also what is known as to the structure of their wings. The true Pterodactyles, as is shown in Fig. 1, are readily

Fig. 2.—Restoration of a Long-tailed Flying Dragon, or Rhamphorhynch. One-seventh natural size (After Marsh.)

characterised by the extreme shortness of the tail; but in another group, also found in the Lithographic limestones, the tail is as long as that of a lizard. The members of this second group are known as Rhamphorhynchs, and the restoration shown in Fig. 2 is taken from a beautiful example found some few years ago, in which the impression of the delicate membrane of the wing is preserved with as much sharpness as if made but yesterday. This and other specimens show that while the front edge of the wing was supported by the elongated finger, the wing extended backwards to embrace the greater part of the hind limb, while the extremity of the tail was furnished with a racquet-shaped expansion of membrane which probably served the purpose of a rudder during flight. Curiously enough, a slab of Lithographic limestone preserved in the museum at Haarlem exhibits a sinuous trail which is believed to have been caused by the extremity of the tail of one of these creatures as it walked across the soft mud now consolidated into stone. The impression of the wings shows that these consisted of a soft leathery membrane, probably something like that of the wing of a bat; and it is quite evident that there were no feathers either on the body or on the wings. The body, like the wings, was, indeed, in all probability entirely naked; and this circumstance militates against the suggestion that the Flying Dragons were warm-blooded creatures, since a protection of either fur or feathers is found necessary in the case of birds and bats to maintain their high temperature. The Rhamphorhynchs occur not only in the Lithographic limestone, which is situated near the top of the great Oolitic system—the system underlying that of the Chalk—but are also found in the much older Lias. Another group, also found in the Lias, are characterised by their short skull and the superiority in size of the front over the hinder teeth, in consequence of which they are known as Dimorphodonts.

Perhaps, however, the most remarkable forms found in the whole group are the toothless types, or Pteranodonts, of which a skull is shown in Fig. 3. In these creatures teeth were totally wanting, and the jaws were probably sheathed in horn, like those of the tortoises (see Knowledge for January), while the hinder or occipital region of the skull was produced into an enormous flattened spine, which also recalls a feature found in the tortoises. Whereas most of the forms we have hitherto noticed did not exceed a rook in size, some of the Pteranodonts were of enormous dimensions, one of them having a skull measuring upwards of four feet in length, and its expanse of wing being probably about twenty-five feet. These Pteranodonts are found in the chalk of the United States; but species nearly as large occur in the chalk of this country, although they were furnished with a powerful armature of teeth, and have been described under the uncouth and exceedingly misleading name of Ornithochirans—the hand or wing of all the Flying Dragons being, as we have already said, as much unlike that of a bird as it well can be. These huge monsters flying through the air must have been a marvellous sight, and they afford one more instance that the wildest dreams of romance have not produced creatures one wit more wonderful than those which at one time had a corporeal existence upon the earth.

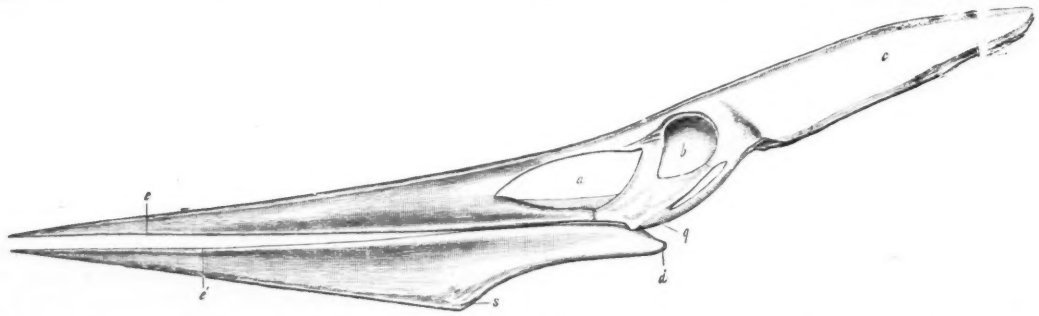

Fig. 3.—Left Side of the Skull of a Toothless Flying Dragon, or Pteranodont. One-sixth natural size. *a*. Vacuity in front of the eye; *b*. Socket of the eye; *c*. Occipital spine; *d*. Angle of lower jaw; *e*. Extremity of upper, and *é*. of lower jaw; *q*. Articulation of the skull proper with the lower jaw; *s*. Points where the two branches of the lower jaw diverge. (After Marsh.)

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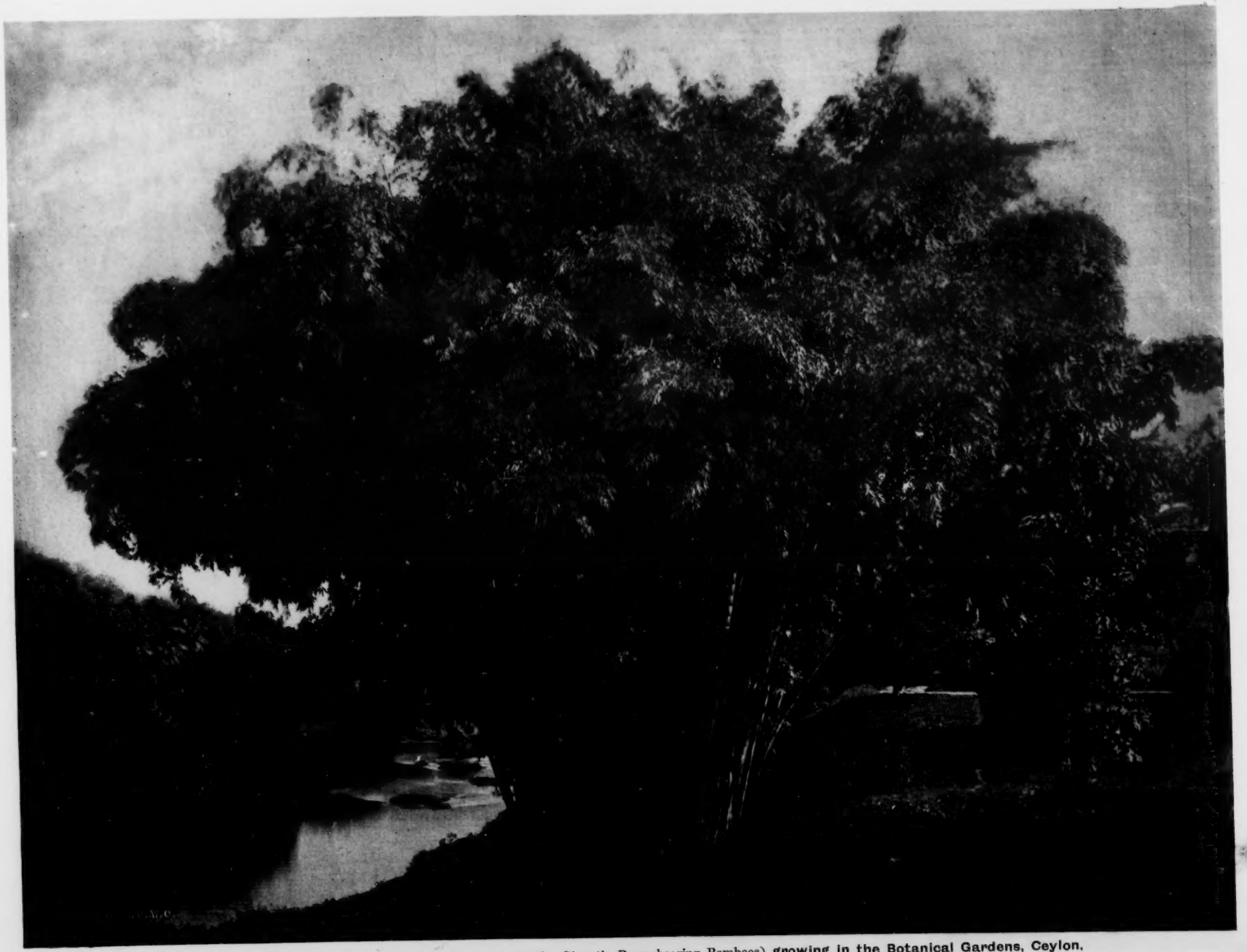

A Cluster of Deudrocalamus Giganteus (one of the Gigantic Berry-bearing Bamboos) **growing in the Botanical Gardens, Ceylon.**

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A Cluster of Deudrocalamus Giganteus (one of the Gigantic Berry-bearing Bamboos) growing in the Botanical Gardens, Ceylon.

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That the Flying Dragons were capable of sustained flight, like birds and bats, seems to be beyond reasonable doubt. It is further quite evident that the toothed forms were of carnivorous habits, and it was suggested years ago, by the late Dean Buckland, that while the smaller species may have subsisted on the dragon-flies and other insects that are known to have lived at the period when the Lithographic limestone was laid down, the larger ones may have preyed on fishes, and perhaps also on the small contemporaneous mammals. It is difficult to suggest what kinds of animals formed the food of the large toothed forms from the English chalk; but in the case of the toothless American monsters it may be pretty safely said that, if they preyed on fish, they must have had a capacious mouth and gullet, and swallowed their prey whole, after the fashion of pelicans and other fish-eating birds.

THE BAMBOO AND ITS KINDRED.

By R. Camper Day, B.A.Oxon.

IF the many families of flowering plants were arranged either in the order of their utility to man or in the order of their abundance, the first place in the list would unquestionably be assigned to the great family of the Grasses. Of their omnipresence and abundance some idea may be obtained from the fact that at least four thousand different kinds have been described, and a German naturalist has estimated that they constitute a twenty-second part of all known plants. Their utility as food-producers becomes obvious as soon as we recall the names of Rice, Wheat, Barley, Oats, Rye, and Indian Corn, and remember how large a proportion of our food is made from their seeds. Most of these civilised and somewhat unnatural grasses have been so long under cultivation, and so much altered by man's selection, that they are totally unfitted to shift for themselves, and would soon become extinct if brought into competition with wild plants. The fact that the wild forms from which they are descended cannot now be identified with certainty shows that their cultivation must date from the very earliest ages. Rice alone is said to furnish more sustenance to the human race than any other single species; the common meadow-grasses, such as the purple-tipped *Anthoxanthum*, which fills the fields with its penetrating fragrance when the hay is newly mown, are almost the only food of sheep and cattle; and those tall and sturdy canes whose juice we squeeze out between rollers, and clarify and crystallise into sugar, are only modified stems of grass.

The largest of the family, and perhaps the most beautiful, is the tropical arborescent grass which bears the name of Bamboo. Although it is not cultivated for the sake of its seed, it has many admirable qualities, and wherever it grows in abundance it is applied to a variety of uses. "The strength, lightness, smoothness, straightness, roundness, and hollowness of the bamboos," says Mr. A. R. Wallace in his *Malay Archipelago*, "the facility and regularity with which they can be split, their many different sizes, the varying length of their joints, the ease with which they can be cut and with which holes can be made through them, their hardness outside, their freedom from any pronounced taste or smell, their great abundance, and the rapidity of their growth and increase, are all qualities which render them useful for a hundred different purposes, to serve which other materials would require much more labour and preparation. The bamboo is one of the most wonderful and beautiful productions of the tropics, and one of nature's most valuable gifts to uncivilised man."

In order that the accuracy of this eulogy may be appreciated, let us imagine the case of a shipwrecked man landing without any tools, except an axe and a knife, upon an island in which we will suppose that bamboos are the only vegetation, and let us see how far he could supply his needs with their assistance. One of his first requirements would be a house, and this could be provided with very little labour. The stems of one of the larger species, such as *Bambusa Brandisii*, driven into the ground, would form excellent uprights for the framework, which could be completed with lighter cross-pieces nailed to the uprights with pegs of the same material. A good roof could be made by taking broad strips split from large bamboos, and fastening them side by side with their concave surfaces uppermost, the interstices between them being covered with other pieces having their convex sides uppermost. Similar but flatter pieces laid upon the joists, and tied down firmly with strips shredded from the outer rind, would form a smooth and elastic floor such as could not be made out of other materials without a great expenditure of labour. Thin strips plaited together, or broad strips pegged side by side, might be used for the walls.

The furnishing of the house would be an easy matter, for bedsteads, chairs, brooms, baskets, cords, fans, bottles, mats, and hoes can be made of bamboo with the greatest facility. The water-tight joints of the stems form admirable water-vessels, and it would be easy to bring the water to the very door by a gently-sloping aqueduct of pieces of bamboo split down the middle and supported at intervals on cross-pieces arranged like the letter X. The jars made from the joints could be utilized not only for holding water, but even for boiling it. Mr. Wallace tells us that rice, fish, and vegetables can be boiled in them to perfection. The young shoots of the bamboo as they first spring from the ground are said to be a delicious vegetable, "quite equal to artichokes." That fish may be readily caught by the agency of the bamboo is shown by the many specimens of ingenious fish-traps exhibited in the museum at Kew. If we suppose our adventurer to take a thin stem of bamboo, and cut off the end obliquely just above a joint so as to leave a sharp edge, he would be provided with a hard-pointed and very efficient spear. In the same way he could supply himself with daggers and arrows; while from the more elastic species he could make himself a bow, using a thin strip of the outer rind for the bow-string. The lowest internode of *Arthrosylidium Schomburgkii*, which sometimes attains the extraordinary length of sixteen feet, far surpassing the length of the joints in all other bamboos (says General Munro), furnishes the "sarbican" or blow-pipe through which poisoned arrows are blown by the natives of Guiana. In the island of Celebes the only article of dress worn by the natives is a body-cloth called Kian Pakkian, made of bamboo slit into fine shreds, which are passed between the teeth and bitten until they are soft, when they are woven.

If after providing himself with these and similar necessaries our shipwrecked man found leisure to amuse himself, he might make Æolian flutes, such as Sir Emerson Tennant saw in Malacca, by boring holes in the stems of living bamboos, or he might construct a harp like that in the Kew Museum which was brought from Timor by Mr. Wallace. This harp is made from a cylinder of bamboo having a node at each end. Under a strip of the outer rind a quarter of an inch wide, a sharp knife is passed so that the strip is detached from the cylinder except at its two ends. The strip forms one of the harp strings. Two small wedges are pushed under it, and the portion between the wedges can then be sounded like the string of a guitar. It is also possible, and not very difficult, to make such

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diverse articles as paper, pens, waterproof clothing, hats, wax, pickles, bird-whistles, rafts, pillows, fermented drink, and bridges from the same versatile vegetable. In the Kew Museum, which should be visited by everyone who wishes to see the varied uses to which bamboos can be applied, perhaps the most curious article is a headsman's knife lately brought by Mr. Franks from the south-eastern peninsula of New Guinea. This singular implement, which is shaped like a cheese-scoop and seems very ill-adapted to its purpose, is marked with numerous notches, each notch representing one of its victims; and it is accompanied by an artistic apparatus, also of bamboo, intended apparently to enable the executioner to carry the severed head.

The bamboo usually grows in a cluster of from ten to a hundred stalks, all springing from the same rhizome or root-stock. The rhizome is not the root but an underground portion of the stem. It consists of a number of segments about the size and shape of a banana and somewhat bloated in the middle. The banana-like segments are joined together irregularly by their tips, so that the whole rhizome forms a strong underground trelliswork admirably adapted to support the light and yet rigid stems that rise up from it. From the under side of the rhizome spring downwards the true root-fibres, numerous as the bristles of a broom.

The stem itself, as everyone knows, is smooth, polished, and cylindrical, and is divided into air-tight compartments by knots or nodes, which are the points at which the fibres of the stem cross over from one side to the other.

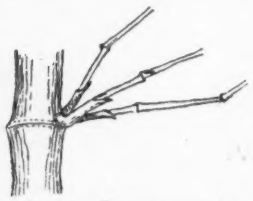


Fig. 1.—Branches from Node of Bamboo.

The lowest ten nodes or so are usually bare, but from the upper nodes issue branches, as shown in Fig. 1. These are very slender as compared with the main stem, and carry the foliage leaves, one of which is shown in Fig. 2. In most species the leaves are rather small, but in some they are very large. The species named *Planotia nobilis* by General Munro, a native of New Granada, has the largest leaves of any kind of grass; they are often a foot in diameter and fifteen feet in length. It will be seen that the leaf given in the figure (*Bambusa vulgaris*) is not quite symmetrical in shape. It is smooth on both sides, except that along the edges there is a roughness, plainly perceptible to the finger, such as is often found in grass-leaves. Each leaf bends gracefully downwards, and the whole plant has a very light and feathery appearance as it waves in the wind. Our full-page illustration is a photograph of a cluster of *Deudrocalamus Giganteus* (one of the berry-bearing kinds) growing in the Botanical Gardens, Ceylon.

The most important part of the bamboo, from a botanical point of view, is the flower, which roughly resembles the flower of our common grasses. The flower of grass is enclosed in hard scaly leaflets called glumes; it usually has three stamens and one seed-vessel. There may be only one flower enclosed in the glumes (as in Foxtail grass), or more (as in wheat). The flowers of the bamboos, while on the whole conforming to the grass type, exhibit many small differences in different species. In some kinds, as in *Arthrostylidium longiflorum*, the inflorescence resembles a bunch of ears of wheat; in others, as in *Bambusa vulgaris*, the flowers are packed into round clusters, as shown in Fig. 3; in others, as in *Chusquea simpliciflora*, they are in threes and fours, each flower hanging by a separate slender stalk. The seed generally resembles oats or wheat, but in some species it takes the form of a berry, not unlike the seed of our familiar pimpernels. In the species known as *Melocanna* the fruit is exceptionally developed, often attaining the size of a largish pear. Some species flower and die down annually; others flower annually, but live on; as a rule, the bamboo grows for many years without flowering, and then suddenly bursts into bloom. From the fact that the number of years between the sowing of the seed and the flowering of the plant varies, and that in some years nearly all the bamboos in a given district flower simultaneously, it would seem as if the blossoming does not take place at any prescribed age, but may occur at any period after the plants reach maturity, when a favourable season supervenes. It used to be thought that after the general flowering of the bamboos throughout a district all the plants died, but this view proves to be incorrect. The flowering shoots usually die, and during the flowering the foliage almost entirely disappears, but the entire plant is not necessarily killed.

Fig. 3. Inflorescence of *Bambusa Vulgaris*.

The Chinese have a proverb that the bamboo produces seed most abundantly in years when the rice crop fails, and several curious cases of the truth of the saying have been recorded. According to General Munro, in 1812 the universal flowering in Orissa prevented a famine. Hundreds of people, he says, were on the watch day and night to secure the seeds as they fell from the branches. Another instance occurred in 1864, when there was a general flowering of the bamboo in the Soopa jungles, and very large numbers of persons came from the neighbouring districts to collect the seeds.

In most bamboos the stem is characterised by straightness, smoothness, roundness, and quickness of growth, no doubt because these qualities have as a rule proved serviceable to the plant in the struggle for existence. Light and air being necessary to the life of grass, it is manifest that in the dense vegetation of the tropics a plant which can push itself rapidly to a great height must have an advantage; and in order that growth may be rapid and the plant spring up to a considerable height without climbing, it is essential that there should be as little material as possible in the stem, and yet that it should be as strong as possible. It is difficult to imagine a stem in which these conditions would be better fulfilled than in that of the bamboo. By reason of its hollowness the amount of material is reduced to a minimum; and by reason of its cylindrical shape, its nodes, and the hardness of the outer rind, the strength of the structure is at a maximum. The growth is consequently very rapid, an increase in height of 2 to $2\frac{1}{2}$ feet having been recorded in a single day. The *Bambusa Brandisii* often measures as many as 120 feet, and is said to attain its full altitude in a few months.

But although, as a general rule, the necessities of natural selection have ordained that bamboos shall be perfectly straight and perfectly round, this archetypal form or idea (to borrow a word from Plato) does not always hold good. One species, found in Asia, is said to have crooked and even creeping stems. Another, found in Ecuador, is described by General Munro as being distinctly a climbing plant. There is a species, recently described by Mr. Thiselton Dyer, with a stem exactly square, and as well-defined as if cut with a knife. It has only lately been found in China,

where it is grown chiefly for ornament. According to Mr. Dyer, the Chinese account for its squareness in the following way. They say that in the fourth century A.D. the famous alchemist, Ko Hung, took his chopsticks (which consist of slender rods of bamboo pared square) and thrust them into the ground of the spiritual monastery near Ningpo; and then, by his thaumaturgical art, he caused them to take root and appear as a new variety—the square bamboo.

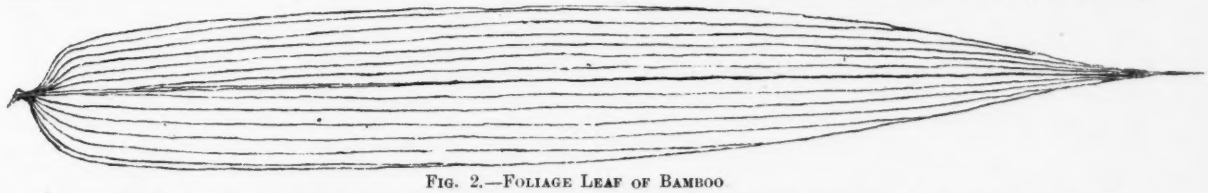


Fig. 2.—Foliage Leaf of Bamboo

The growth of plants is one of the greatest mysteries of nature, and nothing is more mysterious in their growth than their limited but very definite power of movement. How is it that some plants grow vertically upwards, like the normal bamboo, others climb and twist, others creep, and others grow in zigzag shapes? How is it that some turn towards the light, some away from the light, while others place themselves at right angles to it? And how is it that if you peg down the young stem of a vertically growing plant it will bend upwards beyond the peg?* No doubt the proximate cause is natural selection; they do these things because they have found them advantageous. But this does not tell us by what mechanism a plant is enabled to keep on growing in the particular direction which it finds advantageous. We know that when a plant bends in a given direction, the cells on the convex side of the bend are more "turgescent," that is, more distended with sap, than those on the concave side, and that the increased turgescence of the former is followed by increased rapidity of growth; but what causes the distribution of turgescence in the cells has not been clearly made out. It seems probable, however, that when a shoot is growing in its proper and natural direction, the chief force which guides it and enables it to maintain that direction is the force of gravitation. To this force the growing portions of a plant are extremely sensitive. Consider, for example, the case of a vertically growing shoot. Whenever it is accidentally bent the force of gravity must evidently act upon the portion above the bend, tending to curve it still more, and causing a strain in the material of the stem. The plant in some mysterious way is aware of this strain, and the cells of the lower side of the bent portion are stimulated to increased turgescence as compared with those of the upper side, so that the under side would grow faster; and, as the plant would turn upwards in consequence, any deviation from the perpendicular would tend to correct itself. Similarly a shoot which grows horizontally is led by the same stimulus of gravitation to rectify any departure from a horizontal position. Gravitation, then, does not *cause* the bending when a displaced shoot endeavours to regain its normal direction, but serves merely as a guide. By its means the plant is made aware (so to speak) that it has been displaced, and takes measures accordingly. If the force of gravity were absent, the shoot would go on growing in any position in which it might happen to be placed. This may be proved by causing a growing seed to revolve slowly round a horizontal axis, so that at every revolution the force of gravity may act upon it equally in all directions. When a shoot is grown in these conditions, it is found that its power of correcting deviations from any particular line of growth is lost. Similar reasoning applies to the action of light on plants, but, as above stated, we do not know why it is that plants respond to the stimulus of light or gravity; we only know that as a matter of fact they do so.

[* A most remarkable substance called Tabasheer is occasionally found within the joints of Bamboo which have been stunted in their growth. From time immemorial it has been used as a drug, and seems to have been introduced into Europe by Arab physicians, who gave it its peculiar name. It has the smallest refractive index of any known solid, and seems to be a colloidal (that is, non-crystalline) form of silica, containing air so intimately mixed with the silica that the vesicles containing the air cannot be seen under the miscroscope. Sir David Brewster was the first to discover the peculiar physical properties of Tabasheer; he found that its refractive index was *less than that of water*, varying from 1·1111 in some yellowish specimens of Tabasheer from Vellore, to 1·1825 in some whitish Tabasheer from Nagpore. It is never perfectly clear, but always has an opalescent appearance, probably due to the scattering of light by small vesicles of air. Mr. Thiselton Dyer says that it is always found on the *floor* of the joint, except when the Tabasheer-bearing joint leans over, when it is always found on the lower wall.—A. C. Ranyard.]

Notices of Books.

A Manual of Palæontology for the Use of Students. By Henry Alleyne Nicholson, M.D., D.Sc., F.R.S., &c., and Richard Lydekker, B.A., F.Z.S., &c. (William Blackwood & Sons, Edinburgh and London. 1889.) Palæontology, or the study of fossil animals and plants, is every year attracting a greater number of devotees, and among them are found not only the geologist, to whom some knowledge of the organisms which he meets with in the various strata is a matter of necessity, but also the biologist, who finds that many of the problems presented to him in his study of living creatures are elucidated by the investigation of extinct forms. There is still a third class, who make Palæontology their special work, not that they regard it as a science distinct from Biology, but rather as one of its larger branches, demanding for its cultivation all the scientific energy of a lifetime; at the same time they are well aware, or should be, that the key by which fossil mysteries are to be unlocked is a sound knowledge of the structure of living forms.

By all these students the third edition of Dr. H. A. Nicholson's *Manual of Palæontology*, which has just been issued, will be gladly welcomed. The fact that it has been found necessary to enlarge the work from less than 1,000 pages to upwards of 1,600 pages, and at the same time to use smaller type, is in itself an indication of the wide field which it covers. The book is now practically a new one, having been entirely re-written, and the portion treating of the Vertebrata, which occupies the greater part of the second volume, is the work of Mr. R. Lydekker, whose writings on fossil mammals and reptiles are as well known as are those of Dr. H. A. Nicholson on many groups of the Invertebrata. This division of labour, supplemented, as the authors acknowledge, by assistance from several specialists, greatly enhances the value of the work.

The reader who is not well versed in geology should read carefully the introductory chapters dealing with the sedimentary rocks and the conditions under which animal and vegetable remains have become embedded, and are

now found, constituting, as they do in many cases, a large proportion of the stratum in which they are preserved.

No classification of the animal kingdom can be regarded as more than a temporary convenience, for the rapid advance of biological knowledge will soon render some modification necessary. It is not surprising, therefore, to see important changes in the tabular view of the animal kingdom given at page 87. The sponges, having been shown to possess a more complex organization than is found in any true Protozoan, are placed in a separate sub-kingdom, the *Porifera*, thus keeping them distinct from both Protozoa and Cœlenterata. The Ascidians, or Tunicata, are now placed next to the Vertebrata. The Odontornithes or Toothed birds of North America are no longer kept as a distinct group; but those with a raft-like breast-bone are placed in the Ratitæ, and those with a keel to the breast-bone are included in the Carinatæ.

Another change, of a different character, but of no little importance, is the use of black letters and varied types for the headings and different groups; by this means the eye is much assisted, and the arrangement is more clearly impressed on the mind.

In a work dedicated especially to fossil forms, space could not be spared for a very full description of recent types; nevertheless, the authors have given such an account of the general structure of each group that the subsequent descriptions of the different forms are perfectly intelligible.

It is pleasing to find that Dr. Nicholson is not one of those who are given to change; at least, he has retained the time-honoured and expressive term Lamellibranchiata, rather than use the less satisfactory name which has obtained favour with some Malacologists. The Ammonitidæ are at present in a transitional stage, and much work has yet to be done before their grouping can be settled. The *Ammonites*, however, are among the most important fossils found in the Secondary rocks, for the determination of zones of life, and have been used for this purpose with good results in marking the lesser divisions of the Lias and other formations.

The restorations of ganoid fishes given in the early part of the second volume are very instructive, and being mostly from the hands of masters in Ichthyology may be depended upon as embodying facts of nature; more especially may be noted the figures of *Pterichthys*, of *Chondrosteus*, and of *Palæoniscus*, which are the result of much patient work on the part of one of our most eminent palæichthyologists, Dr. R. H. Traquair.

Mr. Lydekker has been much occupied of late among the fossil Reptilia, and we here find an embodiment of his own labours and those of other workers both in this country and abroad. The discovery some few years ago of almost perfect skeletons of iguanodons in the Wealden of Belgium, and their exhibition in the Brussels Museum, lent a new interest to the more fragmentary remains found in Britain, some of which belong to forms identical with the Belgian species. It is, however, in America that the most remarkable dinosaurs have been found, some of them being of gigantic size. According to Prof. Marsh, *Brontosaurus* was about 50 feet in length, with a footprint covering nearly a square yard, while its weight must have been more than twenty tons. Another of these creatures, named *Atlantosaurus*, seems to have been even larger than this. Evidence of forms allied to some of these American giants, but apparently not so large, has been found in the Wealden of this country.

The remains of fossil birds are not numerous, but some have an exceptional interest. The *Archæopteryx*, from the lithographic slates, remains the oldest, as it is the most primitive type of bird yet discovered. Additional evidence has of late years been forthcoming that gigantic birds, equalling in size some of the larger forms of the New Zealand *Dinornis*, lived in Britain, as well as on the Continent and in North America, in early Eocene times.

The genus *Microlestes*, as represented by isolated teeth from the Trias of Würtemberg and of England, has for long been the only known mammal from beds of so early a date; but Sir Richard Owen has now described a remarkable skull, from beds of about the same age, in South Africa, which he has named *Tritylodon*. This has multibercular molars, accompanied by large incisor teeth, and it is believed to have belonged to a low type of mammal.

Special attention is directed by the author to the genealogy of the horse, as one of the best instances of evolution among the higher mammals which has yet been worked out. The gradual changes in the pattern of the teeth and the increase in the number of digits, are traced from the recent horse with one functional toe and two splint bones, through *Hipparion* with its three digits, two of which are small, and *Anchitherium*, with three digits all reaching the ground, to *Hyracotherium*, with its four functional digits of approximately the same size, the last-named animal occurring in the lower Eocene.

It is impossible here to discuss the hypothesis advocated by Mr. Lydekker, that the horses of America and Europe have been independently developed in the two countries along parallel but distinct lines; but this certainly seems less in accordance with known facts than does the supposition that from early Eocene times until the Pliocene period there were frequent, if not continuous, opportunities of intercommunication between the northern parts of Europe, Asia, and America.

The ponderous *Dinocerata* from the Eocene of Wyoming, are remarkable mammals of a primitive type, seeming to combine the characters of several living forms. The skull of one of these, the *Uintatherium*, has been chosen as an illustration for the cover of the second volume; and certainly its form is striking enough, with its six horn-like protuberances from the frontal and nasal regions, and its enormous canine teeth, reminding one of those in the carnivorous genus *Machærodus*.

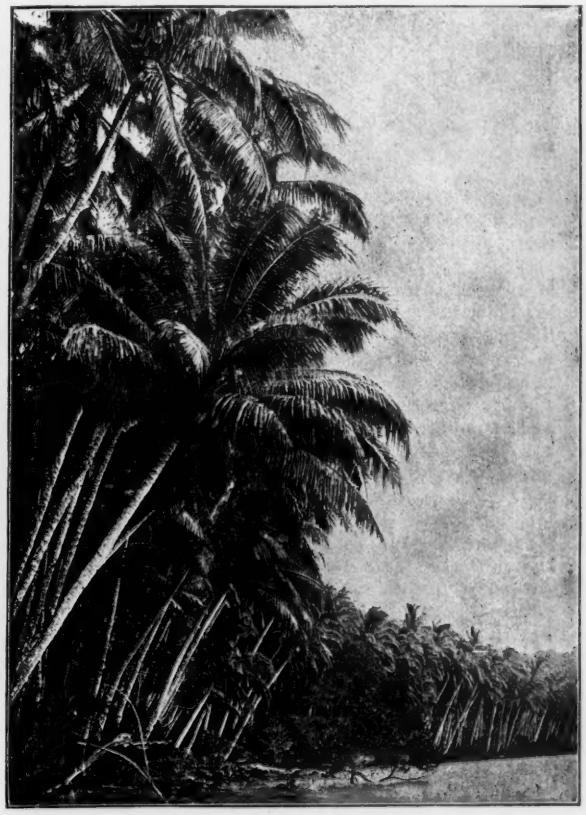
The fourth part of this manual, which treats of Palæobotany, has been much improved; but it professes to be only a general summary of the subject, and is not treated in so detailed a manner as the previous parts.

The work is throughout profusely illustrated, and the figures are for the most part good and well chosen; but some of them are far from being creditable productions, and it is a pity they have been allowed to mar the general excellence of the work. As an example of what woodcuts may and should be, see that on page 1265, and for an example of what they should not be, see page 1283. A few of the figures are misleading, such, for instance, as the mouth of the sturgeon on pages 916 and 975, and the old figure of a Pterodactyl, on page 1203, with four clawed digits to the manus, will lead to more errors than will be rectified by the explanation and correction in the text. These defects, however, are small when compared with the general excellence displayed throughout the two volumes, which contain a large amount of reliable information, brought together in a convenient and readable form; information which would otherwise have to be sought in many separate treatises, often difficult of access. The work, therefore, may be confidently recommended to all who desire a thorough insight into the study of fossils; and moreover, although ten years have elapsed since the publication of the previous edition, this remains the only English manual of Palæontology.—E. T. Newton.

A Naturalist Among the Head Hunters; *being an Account of Three Visits to the Solomon Islands in* 1886, 1887, *and* 1888. By C. M. Woodford. (London: Philip & Son, 1890.) There are many collecting crazes, all of which probably tend to weaken the moral sense. For the ardour of the collector, whether he covets his neighbour's skull or coins or rare Elzevirs, makes him not too careful as to the means whereby the end is reached. We must not therefore judge too harshly or hastily the form which the passion takes among the Solomon Islands' natives and other barbaric peoples, with whom the main business of life appears to be the taking of each other's heads. For head-hunting, although connected with cannibal or sacrificial practices, is often independent of both, being largely

Group of Sago Palms.

due to the desire to collect proofs of skill and power, as, among ourselves, the hunting man adorns his hall with the trophies of the chase. Thus it is that among the natives of the Solomon Islands expeditions are made in large and well-built canoes, by parties numbering thirty or forty men, armed with spears and rifles, who pounce upon the coast villages, and either cut off the heads of the inhabitants or defer that operation till a new canoe is launched or a collection needs additions. The Solomon Islands were discovered in 1568, and were named after the wisest of men by their shrewd discoverer, Mendaña, a Spaniard, with the design that his countrymen, supposing them to be the source whence Solomon obtained his gold, might be induced to colonise them. They were lost sight of for two hundred years, and their existence questioned until their re-discovery towards the end of last century. They are, for the most part, densely wooded, and peopled with tribes between whom internecine strife is chronic. They are full of interest to the geologist and the naturalist, yielding evidence to both that they have not been connected with any continent. Their coasts are fringed with the useful coco-nut palm, traffic in the fruit of which brings out the smartness of the natives, who are always ready to make out that they do not know how many coco-nuts make ten; as a general rule it is seven and a half with them, but sometimes it is only six! Further inland plantations of sago palms flourish in the swampy ground, yielding one crop of nuts and then dying, the once fruitful trunk becoming nothing "but a collection of rotten brown fibres." The main object of Mr. Woodford's visits was to



Cocc-nut Palms. View on the Seashore.

collect the fauna of the islands, in which he was successful, his additions to our knowledge having much interest in themselves, as well as value in their bearing upon the problems of geographical distribution. Among the most remarkable of these additions are a rat which measures two feet from nose to tip of tail, and two genera of bats which form a very important link in the life-history of the Chiroptera, while among more familiar forms of those regions are the great coco-nut robber crabs, monster lizards five feet long, and gorgeous butterflies measuring nine inches across the wings. The natives themselves are typical examples of the result of occasional intercourse with the whites, the varnish but thinly con-

cealing the savage. Fashion sways their lives somewhat, for turkey-red calico is not always worn, sometimes navy-blue being *en règle*, while the approved shape and colour of pipes varies, the natives refusing to exchange coco-nuts for white pipes when the fashion runs on red ones! Their religion manifests the common features of that of barbaric peoples, being a species of ancestor-worship, with belief in spirits, mostly of malign nature, everywhere, to whom propitiatory offerings are made. One hopeful sign among them is that they more and more incline to conceal the real motive of their head-hunting voyages, and will say that they are going for turtle-shell. But tribe after tribe has been effaced, and the extinction of the rest is certain. Mr. Woodford both prefaces and concludes his book with apologies for lack of literary style. They are needless, for his narrative is written in a direct, straightforward way, with honest ring in the words that will not fail to commend it as a worthy addition to the growing body of literature of travel in Melanesia. The value of the book is increased by remarkably good reproductions of excellent photographs taken by Mr. Woodford, as evidenced by the two specimens which the publishers kindly allow us to print; by three clear maps, and by a fairly full index.

Idylls of the Field. By Francis A. Knight. (Elliot Stock.) Under this title the gifted author of "By Leafy Ways" has collected into book form a second series of reprints from the *Daily News*. In a number of exquisite word-pictures Mr. Knight vividly portrays some charming country and seaside scenes taken chiefly from the West of England. He looks upon nature with the eye of a poet, and in refined and graceful language tells out the thoughts she inspires. The ever-varying phases of bird- and plant-life are specially attractive to him, and his musings are interspersed with antiquarian touches that stir the reader's imagination and help to link the present with the past in a most delightful manner. His keenness of observation and his full sympathy with the calmer and quieter side of nature are evident throughout; not a rustle among the withered leaves, not a tiny footprint on the freshly-fallen snow, or on the sands round the margin of the secluded pool, but is eloquent to him of secrets that can be revealed only to such sympathetic spirits. No better exemplification of the old truth, that the eye sees only what it brings the power to see, could be found than in these pages, which may profitably be pondered over by any who desire to improve their mental vision. There are several beautiful photogravures and other illustrations, which are in complete harmony with the general tone of the book, and which combine to make it a dainty gift-book for all lovers of nature.

The Butterfly; its History, Development, and Attributes. By John Stuttard. (T. Fisher Unwin.) This booklet originated as a paper read before the Rochdale Literary and Scientific Society. It indicates a good deal of thoughtful reading on the part of an enthusiastic student of nature, who, in what has evidently been a labour of love, has put together in a somewhat unconventional manner a variety of interesting matter bearing on the structure, habits, and uses of butterflies. May we suggest that, if Mr. Stuttard could have prevailed on some scientific friend more skilled in the use of technical terms to do a little "editing" for him, some verbal errors, such as Anthropoda for Arthropoda, chrisos for chrysos, tarsis for tarsus, might have been avoided, and a laudable effort thus rendered more acceptable.

Thermo-electricity. By Arthur Rust. (E. and F. N. Spon. London: 1889).—In this little book another attempt is made to solve the great question, "What is electricity?" The author defines electricity as "a mode of motion, a flow of molecular vibrations produced by the friction of molecules against molecules." The subsequent explanation shows that he differs considerably from other electricians in his conception of the nature of electricity. In the endeavour to establish his position he describes a number of experiments with thermo-electric couples, iron being taken as one of the metals and a compound of zinc and antimony as the other. We could have wished that fuller details of these experiments had been given; for instance, the temperature at the point of junction between the zinc alloy and the galvanometer wire, the resistance of the circuit, and the interval of time (if any) between the application of the heat and the reading of the galvanometer. Full details are the more necessary because Mr. Rust controverts the accepted thermo-electric law that the strength of the current depends on the difference in temperature between the two junctions.

Zenographical Fragments. I. By Stanley Williams, F.R.A.S. (Mitchell & Hughes. London, 1889.) This is in no sense of the word a *popular* work, but one by an expert for experts. Undeterred by the low altitude of the planet in 1886-87, Mr. Williams set to work to make a detailed and systematic examination of all the markings of Jupiter visible in his telescope on every available occasion. He employed a $6\frac{1}{2}$. in Calver silver-on-glass reflector, armed with a single lens giving the comparatively low power of 170, which he found gave the best views of the surface of the planet in its then great southern declination. His object was twofold: to fix, by the method of transits, the longitude of the various spots, and to make detailed observations of the magnitude, brightness, and appearance of every definite marking on the disc. Seventy sketches were made, and an elaborate chart of the markings on Jupiter, reduced to the date of opposition, April 21, 1887, forms the frontispiece of the book. Of course, as Webb remarks, owing to spherical foreshortening large portions of the disc near the poles must remain for ever unknown. The work is divided into seven sections, treating of the instrument employed, the behaviour of individual markings, on their relative altitudes, the mean rotation of spots situated in different latitudes, the apparent repellent influence excited by the great red spot, the colour of which was first noticed in 1868, &c. The illustrations are numerous. The work forms a most excellent monograph of its subject, and is appropriately dedicated to the memory of Schröter.—H. S.

Profitable Fruit-Growing. By John Wright, F.R.H.S. (E. H. May.) The Fruiterers' Company, in order to encourage the culture of fruit amongst cottagers, last year offered a gold medal and prize of twenty-five guineas for the best practical essay on the subject. Mr. Wright was the successful competitor with the present essay. It contains much useful advice, and gives in plain language just the information required as to the planting, pruning, and general management of those kinds of fruit that can easily and profitably be cultivated on small holdings. It is copiously illustrated, and the idea of *profitable* culture is kept clearly in view throughout. Cottagers and other holders of small plots should avail themselves of the help of this essay if they wish to know how to make the most of their ground.

The Cultivated Oranges and Lemons, &c., of India and Ceylon. By E. Bonavia, M.D., Brigade Surgeon, Indian Medical Service. (W. H. Allen & Co., 1890.) Dr. Bonavia has devoted many years to the study of the

numerous varieties of oranges, lemons, and citrons growing in India, with a view of encouraging the development of what he believes might be made a very important industry, in a country where labour is cheap, as compared with California and the Mediterranean littoral, and the climatic conditions are in no way inferior. It seems that many of the Indian varieties grow with little or no artificial irrigation. They are mostly propagated from seed, sown thickly in a seed nursery on prepared earth, till the plants are about four inches high, when they are transplanted and placed eight or nine inches apart, and allowed to grow till they are four years old; they are then again transplanted to the orange gardens where they are intended to grow. The book, though intended for specialists, contains a great deal of interesting information for others besides professional orange-growers. It is accompanied by an Atlas of over 250 plates, showing a remarkable variety in the forms and sizes of fruit; and Dr. Bonavia has given an excellent Index.

Our Eyes, and How to Preserve them from Infancy to Old Age. By John Browning, F.R.A.S. Eighth Edition. (Chatto & Windus.) This is a very useful little book, explaining in simple language, and by means of very numerous illustrations, facts which ought to be widely known in this age of over-taxed eyes. Besides the ordinary explanations as to short sight and astigmatism, and other physical defects of our eyes, it contains some sensible suggestions as to the proper fitting of spectacles, and minor matters which are too little attended to.

The Educational Annual. 1890. Compiled by Edward Johnson. (George Philip & Son.) This is a useful compilation, putting into small compass a large amount of information on all kinds of educational matters pertaining to all grades from the elementary schools to the universities. The chief deficiency we notice is in connection with secondary education. While good lists, with abundant details, are given of the proprietary and endowed schools, the private schools are almost entirely ignored. And yet many of these, whatever may have been their condition in past years, are now doing excellent educational work, as is testified by the extent to which they figure in the University Local Examinations.

We regret to announce the death of Prof. Montigny, well known for his researches on the scintillation of stars, on the 16th of March. He died at Schaerbeek, near Brussels, after a short illness. He was born in January 1819, and was consequently in his 72nd year.

The photograph of a sun-spot given in the February number of Knowledge was enlarged from a photograph taken by M. Janssen on the 28th of June 1885. On the scale of the enlargement the sun's disc would be 1·40 meters in diameter.

Letters.

[The Editor does not hold himself responsible for the opinions or statements of correspondents.]

ASTRONOMICAL PHOTOGRAPHY.

To the Editor of Knowledge.

Dear Sir,—I beg you to accept my thanks for a copy of Knowledge containing your interesting article on stellar parallax, and Mr. Sadler's valuable collection of results, the most complete that I have seen.

Your criticism of the accuracy of results obtained from photographs is timely, since this method needs as careful examination as any other. There is a tendency at present to extol the exactness of the photographs without stopping to measure and discuss them, and we already have a demand for fire-proof buildings in which to stow the plates. Thus astronomy is in danger of being reduced to the condition of meteorology, where a million observations more or less are of no account. In 1874 I was shown a photograph of Venus *in transitu*, with the remark, *One photograph is sufficient!* as though a few photographs would settle for ever the distance of the sun The discussion of the American photographs of the transits of 1874 and 1882, nearly two thousand in number, gives for the probable error of the position of Venus from a single plate about half a second of arc; that is, the photographic plate has approximately the same degree of accuracy as an observation with a meridian circle. Our photographs of these transits are beginning to deteriorate, and it is well that the plates have been measured and the results secured.

Still, it appears to me that the photographic method does furnish certain real advantages for the determination of stellar parallax. These come largely, I think, from the fact that we have on the same plate stars of comparison in various directions and distances, and that by means of these we are enabled to eliminate constant errors, which are the most dangerous in this kind of work. The heliometer presents similar advantages, but the photographs have over this instrument the advantage of much greater ease in observing. It remains to be shown what degree of accuracy can be obtained from recent photographs in measuring relative positions. The results published from the Potsdam observatory indicate an accuracy equal to that of the best micrometrical work.—Yours truly,

U.S. Naval Observatory, Washington.
Feb. 27, 1890. Asaph Hall.

[I fully concur with Prof. Asaph Hall as to the advantages offered by the photographic method, if the probable error of a single measure, made on a photograph, can be relied on as comparable with the probable error of a single eye observation, and I do not doubt that the average deviation from the mean of series of measures made on photographs have been found to be comparable with the average deviation from the mean of eye observations; but we can only assume that the average deviation from the mean is the probable error of a single observation when all systematic errors are eliminated. The most practical test one can apply to determine whether all constant sources of error have been eliminated is the comparison of measures made by independent observers on different photographs. When several such measures confirm one another within the limits of probable error claimed, my faith in the photographic method will increase.—A. C. Ranyard.]

To the Editor of Knowledge.

Sir,—May I be allowed, as an old variable star observer, with all deference, to suggest a doubt whether the diagram in your March number, with its marked angularities, presents a true picture of the light curve of *S. Ursæ Majoris?* The Rousdon observations seem to me to be too loosely scattered to enable one to distinguish with precision between accidental errors of observation and real points on the curve.—I am, Sir, yours faithfully,

George Knott.

Knowle's Lodge, Cuckfield, March 21, 1890.

[One would naturally listen with deference to any criticism from Mr. Knott with respect to the observation of

variable stars. But I think that he has in this instance mistaken Mr. Peek's meaning in supposing that the sharp irregularities of the Rousdon curve are intended to represent the true variations of the star's light. Mr. Peek has simply joined the points corresponding to the brightness of the star at the dates of observation by straight lines—without attempting by freehand drawing to round off any of the angles. Such smoothing of curves must always be a matter of guess-work, and it is probably more desirable to let the diagram represent as exactly as possible the means of the estimates of brightness made at each of the various dates of observation.

The great question of interest is whether it would be possible to conceive of the irregularities shown as only due to accidental errors of observation. It seemed to me that Professor Pickering's observations of *S. Ursæ Majoris*, as well as those made at Rousdon, indicate that there are greater irregularities in the estimates of the star's brightness than can be accounted for by errors of observation in comparing the brightness of the variable with other stars in its neighbourhood, whose brightness would be equally affected with that of the variable by changes from night to night in the clearness of the atmosphere. The question is, however, one on which further observations are much needed.—A. C. Ranyard.]

DIVISIBILITY BY 37.

Dear Sir,—In your March issue Mr. T. S. Barrett has mistaken how to apply the test. Let me show him. His first number was 262774259. Take the sums of every third figure $9+4+2=15$; $5+7+6=18$; $2+7+2=11$. Now take 11 from $18=7$; and 11 from $15=4$, and since $74=37$ M, the given number also $=37$ M.

Again, take 973112691, his other number.

Here the sums of every third figure are 6, 17, 16, respectively, and 16 from $17=1$ (ten), and 16 from $6=-10$. Then since $10-10=0$, the given number $=37$ M.

The mathematical proof of the test is unsuited to your columns, but I shall be happy to forward it to anyone interested. I have constructed simple tests for divisibility by any number.

$r^n \pm r^{n-1} + r^{n-2} \ldots + r \pm 1$ or its factors. There are several tests for the number 7, one of which is easier than the above. My object in the February number was not to give tests of divisibility, but to show the connection between the periodicity and the divisibility. There are other points I should like to have touched upon did your space and the pressure of my business permit.—Yours faithfully,

Robt. W. D. Christie.

Wavertree Park College, Liverpool,
15th March 1890.

P.S.—I take this opportunity of correcting a clerical error on p. 73, lines 23 and 25 from bottom. Instead of 9 $(p-1)/2$ and P $(p-1)/2$, read 9 $(q-1)/2$ and P $(q-1)/2$.

MAGNITUDE OF STARS.

To the Editor of Knowledge.

Sir,—Referring once more to the diagram of the distances of the fixed stars in your February issue, I should like to ask if it is possible to infer what magnitude of star our own sun would correspond to, if it were placed at the distance of α Centauri, or Sirius.

Thanking you for your answer to my former question,
I remain,

Tynron, Scotland, Yours truly,
12 March 1890. J. Shaw.

[Various determinations of the light of the sun as compared with the light of the full moon, and the light of the moon as compared with that of stars, have been made. Huyghens, in 1698, compared the light of the sun with that of Sirius by allowing the light of the sun to shine through a minute hole. According to his experiments, the sun gives 756,000,000 times the light of Sirius. Wollaston, in 1829, compared the image of the sun and of a lamp reflected in a silvered bulb of glass with the light of Sirius. According to these experiments, the sun gives 20,000,000,000 times the light of Sirius.* Steinheil, in 1836, from comparisons between the light of the sun and moon, and that of Sirius, gave the ratio as 3,840,000,000. In 1861, Bond determined the relative light of the sun and moon by comparing their reflections in a glass globe with that of an artificial light. Combining his measures with the comparisons of the moon and Sirius by Herschel and Seidel, he deduced the ratio 5,970,500,000.† In 1863, Clark found that, if the sun was removed to 1,200,000 times its present distance, and Sirius to 20 times its present distance, they would appear equally bright, and equal to a sixth-magnitude star. This corresponds to a ratio of 3,600,000,000 between the light given by the sun and Sirius. Prof. E. C. Pickering, in his remarkable paper on Algol, published in the proceedings of the American Academy for 1880, computes the brightness of the sun, measured in star magnitudes from Huyghen's measures, as 22·2 magnitudes brighter than Sirius; from Wollaston's measures, 25·75 magnitudes; Steinheil's, 23·96; Bond's, 24·44; and Clark's, 23·89; from which Prof. Pickering assumes (taking Sirius as of the −1·5 magnitude) that the light of our sun, measured in stellar magnitudes, may be considered as corresponding to about minus twenty-five and a half magnitudes of the stellar scale.

The scale of star magnitudes has been so arranged that if any star were removed to ten times its present distance (where it would give a hundredth part of its present light) its brightness would be decreased five magnitudes. Consequently, if the sun were removed to a hundred thousand times its present distance (*i.e.* to a distance of about $1\frac{1}{2}$ light years), it would, according to Prof. Pickering's estimate, appear about one magnitude less bright than Sirius, and at the distance of *α Centauri* it would not differ greatly from a star of the first magnitude.—A. C. Ranyard.]

THE MEANING OF A MINUS PARALLAX.

Sir,—Will you kindly explain how a minus parallax is obtained, and what it means?—Yours faithfully,

J. F. King.

[In the case of an absolute parallax, it must be taken to mean that there is some systematic error which vitiates the observations. But in the case of a relative parallax it may mean that the comparison star or stars are nearer than the star whose shift in the heavens is measured.—A. C. Ranyard.]

To the Editor of Knowledge.

Dear Sir,—With regard to the list by Mr. Sadler following your own most interesting article on stellar parallax in the number of Knowledge for February,

* Phil. Trans. cxix. 28.
† Mem. Amer. Acad. viii., N.S., p. 298.

there are two points on which I should like to address a few words to you. (1st.) The various cases where two or more distinct values are given for the parallax of a star, the observer, method, date, publication, &c., being the same, and there being nothing to show that a redetermination has been made, as in the case of γ Cassiopeiae, where the values (neglecting probable errors) of 0″·14, +0″·007, 0″·025, and +0″·050 are given. Are these to be regarded as four distinct determinations, each from observations extending through one year? In the case of Polaris, the values + 0″·073 and + 0″·079 are given. From a consideration of your note on p. 62, I conclude that Mr. Sadler's list, though in type, was open for new results at least as far as November 7, 1889; yet in the number of *Nature* for that date (vol. xli., No. 1045, p. 19), in mention of Professor Pritchard's *Researches in Stellar Parallax*, the value given for Polaris is +0″·052±0″·011; and as far back as July 5, 1888, it is stated in *Nature* (vol. xxxviii., No. 975, pp. 227-8), with regard to the Oxford observations, that the determinations of 61^1 and 61^2 *Cygni*, μ *Cassiopeiae*, and *Polaris* "may be regarded as nearly completed," and the result for Polaris is given as +0″·052±0″·0314, of which I take the above-mentioned result of +0″·052±0″·011 to be the completion. Adding this value to the two given in the list, we have for Professor Pritchard's results the values +0″·073, +0″·079, and +0″·052. To take an example other than the Oxford observations, I may refer to p. 66, where Brünnow's (1870-71) result for Vega is given as +0″·131 and +0″·188. β and α *Cassiopeiae* are also cases in point, and for these two stars and γ *Cassiopeiae* the same date, viz. 1888, is given as the time of observation, from which I understand (for in other cases the number of years is given through which the observations extend) that these stars have only been observed by Professor Pritchard through one year; yet if this be so, how have the widely differing determinations been obtained? I venture to hope that if the points admit of a brief explanation Mr. Sadler or yourself will be good enough to devote a few lines to the subject.—Yours most faithfully,

"γ Draconis."

Galashiels, N.B.

[Your correspondent (who, I regret, does not give his name) is perfectly correct in his criticism. There is a difference in the results which have been published by Professor Pritchard in the *Monthly Notices* and in the Oxford observations. The difference between these and the results communicated to *Nature* (before the publication of the Oxford determinations) may be due to the fact that in the case mentioned of *Polaris* the parallax as derived from only one of the comparison stars is given. Possibly Professor Pritchard may not be himself responsible for this. It is one of the disadvantages of premature announcements that incomplete results, which subsequently receive modification, are published. In the case of γ Cassiopeiae, 0″·14 is misprinted in my paper for 0″·014. The same stars are not always employed in the two determinations. As I have said above, I presume that the writer of the articles in *Nature* has taken the parallax of Polaris as determined from the brightest of the four stars observed at Oxford (B. D. +88°, No. 4, 6·7 mag., in *Monthly Notices*, 6·84 mag. in Oxford University observations). The parallax of Polaris from the star is given in the *Monthly Notices* as +0″·0429+0″·015, and in the Oxford University observations as +0″·052±0″·011. In the case of *Vega*, the differences in Brünnow's results are due to his accepting or rejecting certain constant errors. "γ Draconis" must refer to the original papers for information of this kind, which it was impossible to give in the limits of a magazine article.—H. Sadler.]

THE FACE OF THE SKY FOR APRIL.

By Herbert Sadler, F.R.A.S.

SUN-SPOTS have been rare of late, but at the time of writing a fine double one is entering on the solar limb. The Zodiacal light should be looked for in the absence of moonlight during the second and third weeks of the month. Mercury is invisible during the first half of the month, being in superior conjunction with the sun at 8h. a.m. on the 9th. During the latter half of the month the planet will be more favourably placed, setting on the 23rd at 8h. 42m. p.m. with an apparent diameter of 6″, and a northern declination of 19°, and on the 30th at 9h. 24m. p.m., 2h. 5m. after sunset, with an apparent diameter of 7″, and a northern declination of 22¾°. While visible he passes from Aries into Taurus, being about 20′ *s.p.* the 4th magnitude star δ Arietis on the 23rd at 8 p.m.; at the same hour on the 25th he will be about 6′ *s.f.* the 6th magnitude star 65 Arietis, and on the evening of the 28th about 2° south of the Pleiades. Venus is an evening star throughout the month, setting on the 1st at 7h. 27m. p.m. with a northern declination of 7¾°, and having a slightly gibbous disc subtending an angle of 10″; on the 30th she sets at 9h. 0m. p.m. with a northern declination of 20° and an apparent diameter of 10¼″. During the month she passes from Pisces through Aries into Taurus, but without approaching any conspicuous star very closely. Mars is an evening star, rising on the 1st at 11h. 50m. p.m. with a southern declination of 21° 21′, and an apparent diameter of 14″; on the 30th he rises at 10h. 12m. p.m. with a southern declination of 22° 39′, and an apparent diameter of 18½″. During the month he passes through portions of Scorpio and Ophiuchus, but does not approach any naked-eye star very closely. He is stationary at midnight on the 22nd. Pallas is in opposition to the sun on the 29th, when she is at a distance of 178¼ millions of miles from the earth, and appears as a 7·4 magnitude star. Her diameter is given, from photometrical considerations, by Argelander at 158 miles, Pickering 167, Stone 171. Lamont, from measurements of the diameter of the disc, found 630 miles; Schröter exceeded all bounds by giving one of 2,030 miles. During the month she passes from Serpens into Corona Borealis. On the night of the 3rd, about midnight, she is 4′ due north of the 6·0 magnitude star τ^8 Serpentis, and on the 8th about 15′ *n.f.* to the 6·0 magnitude star τ^7 Serpentis. On the night of the 10th she is 27′ due south of the 4½ magnitude star ι Serpentis. Jupiter is a morning star, rising on the 1st at 3h. 37m. a.m., with a southern declination of 18¾°, and an apparent diameter of 33½″. On the 30th he rises at 1h. 54m. a.m. with a southern declination of 18°, and an apparent diameter of 36½″. The following phenomena of the satellites occur while the planet is more than 8° above, and the sun 8° below the horizon. A reappearance from eclipse of the third satellite at 4h. 47m. 36s. a.m. on the 2nd. An egress from transit of the third satellite at 4h. 6m. a.m. on the 13th. A reappearance from occultation of the second satellite at 3h. 29m. a.m. on the 24th, and an ingress of the first satellite on the disc one minute later. An ingress of the shadow of the third satellite at 3h. 17m. a.m. on the 27th. Jupiter is in Capricornus throughout the month. On the mornings of the 5th and 7th a very pretty double star, 6½ and 7·0 magnitudes, 15½″ apart, will be noticed in the field of view a little north of the planet. On the morning of the 10th a 6½ magnitude star will be about 7′ north of the planet. On the morning of the 15th the 6th magnitude star 19 Capricorni will be about 2½′ north of the planet. Saturn is still in a favourable position for observation, rising on the 1st

XUM

at 2h. 4m. P.M. with a northern declination of 13° 54′, and an apparent diameter of 19″ (the major axis of the ring-system being 44″ in diameter, and the minor 8½″). On the 30th he rises at 0h. 7m. P.M. and souths at 7h. 25m. P.M. with a northern declination of 14° 5′, and an apparent diameter of 18¼″ (the major axis of the ring being 42″ in diameter, and the minor 8″). On April 8th, at 8h. P.M., Dione and Iapetus are in conjunction. At about a quarter to five P.M. on the 9th Iapetus is occulted by the ring, the disappearance being 3″ to the north, the emergence taking place in broad daylight the next day. Uranus rises on the 1st at 7h. 36m. P.M. with a southern declination of 9¼° and an apparent diameter of 3·8″. He rises on the 30th at 5h. 31m. P.M. with a southern declination of 8¾°. He is in opposition on the 14th, when his distance from the earth is about 1,620 millions of miles, and the magnitude of the planet 5·4 in the photometric scale. He describes a short path in Virgo, nearly midway between the stars 76 and 82 Virginis. Neptune has practically left us for the season. Shooting stars are fairly plentiful in April, the most marked shower being that of the Lyrids, with a radiant point in 18h. 0m. R.A. + 33° Decl. The radiant point rises on the nights of the 19th and 20th, when the maximum occurs, at 6h. 27m. P.M., and souths at 4h. 8m. A.M. The moon is full at 9h 24m. A.M. on the 5th, enters her last quarter at 10h. 53m. A.M. on the 12th, is new at 8h. 5m. A.M. on the 19th, and enters her first quarter at 4h. 52m. A.M. on the 27th. On the 5th, at 8h. 32m. P.M., the 6th magnitude star 80 Virginis will disappear at an angle of 90° from the lunar vertex, and reappear at 9h. 1m. P.M. at an angle of 145°. At 2h. 33m. A.M. on the 8th the 6th magnitude star ζ′ Libræ will disappear at an angle of 112° from the vertex, and reappear at 3h. 28m. A.M. at an angle of 215°. At 0h. 58m. A.M. on the 11th the 6½ magnitude star B.A.C. 6217 will disappear at an angle of 29° from the lunar vertex (the star is below the horizon at the time), and reappear at 2h. 0m. A.M. at an angle of 250°. At 10h. 40m. P.M. on the 22nd the 5th magnitude star ι Tauri will make a near approach to the lunar limb at an angle of 219° from the vertex. At 11h. 41m. P.M. on the 24th the 6th magnitude star B.A.C. 2238 will disappear at an angle of 135° from the vertex, and reappear at 0h. 32m. A.M. on the 25th at an angle of 285° from the vertex. On the 30th, at 11h. 0m. P.M., the 4th magnitude star ν Virginis will disappear at an angle of 129° from the vertex, and reappear at 11h. 48m. P.M. at an angle of 221° from the vertex.

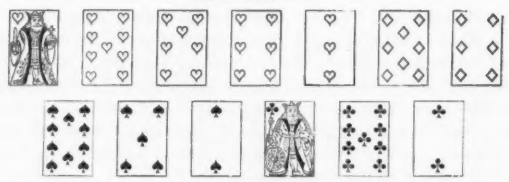
Whist Column.

By W. Montagu Gattie.

FORCING A DISCARD.

SOME of the finest strokes of play at whist consist in forcing an adversary to make a disadvantageous discard. To take a simple case. Four cards being left in each hand, A, who has to lead, finds himself with the last trump, and one small card at least in two suits of which Y (his left-hand adversary) holds the second and third best, and B (A's partner) the best and a small one, while Z's cards are of no consequence. By leading out his trump A secures all the four tricks; for, whichever suit Y discards from, B discards from the other, A leads the suit from which Y has discarded, and B makes the three remaining tricks. On the other hand, if A were to lead one of his plain-suit cards instead of the trump, nothing could prevent Y from making a trick. The following hand furnishes a more complex illustration of the same principle :—

Hand No. 10.

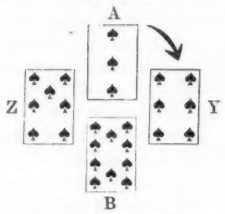


B's Hand.

Score—Three All. Z turns up the Queen of Hearts.

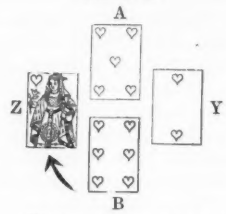
Note.—A and B are partners against Y and Z. A has the first lead; Z is the dealer. The card of the leader to each trick is indicated by an arrow.

Trick 1.



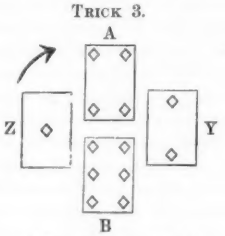
Tricks—AB, 1; YZ, 0.

Trick 2.



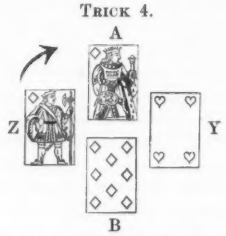
Tricks—AB, 1; YZ, 1.

Trick 3.



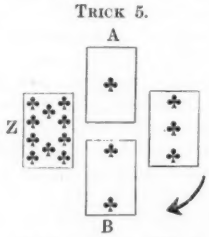
Tricks—AB, 1; YZ, 2.

Trick 4.



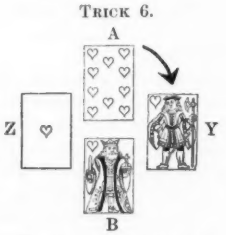
Tricks—AB, 1; YZ, 3.

Trick 5.



Tricks—AB, 2; YZ, 3.

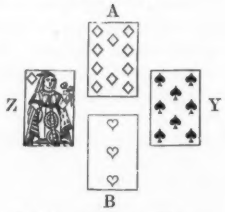
Trick 6.



Tricks—AB, 2; YZ, 4.

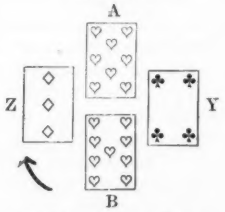
Note.—*Trick* 5.—It is quite possible that Y may have led from three clubs to the queen in preference to returning the spades up to A's strength.

Trick 7.



Tricks—AB, 3; YZ, 4.

Trick 8.



Tricks—AB, 4; YZ, 4.

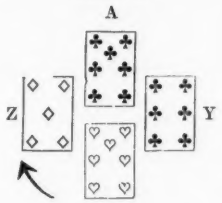
Notes.—*Trick* 7.—Y's discard shows that Z has no more spades (see trick 1), so that Z's remaining cards are four diamonds and two clubs. It follows that, if Y has three clubs left, A cannot have more than two. B himself

holds the two of spades, and consequently knows that A's three (trick 1) was not a penultimate, *i.e.* that A has only three more spades. Therefore, unless Y's lead at trick 5 was from three clubs only, A must hold the other trump.

Trick 8.—B nevertheless draws the trump. If Y holds the major tenace in spades, the game is hopeless, honours being declared against AB; but if he holds king, knave, against A's ace, queen (the only other possible case), the game may be saved by throwing the lead into his hand at the right moment, and compelling him to lead spades up to A. Continuing the clubs at this point would be fatal if the other trump should turn out to be with Y.

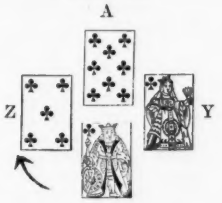
Y's discard is the best under the circumstances (see B's inference from trick 8 in the analysis given below).

Trick 9.



Tricks—AB, 5; YZ, 4.

Trick 10.



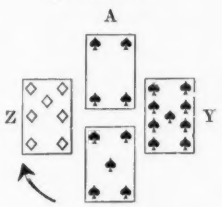
Tricks—AB, 6; YZ, 4.

Notes.—*Trick* 9.—Z probably has either queen, knave, of clubs, or knave guarded; and, if B now continues with king and another club, Z, after getting in, will force him in diamonds, obliging him, after all, to lead spades up to Y.

Y again discards a club for the same reason as before. It is, however, interesting to notice that, if he discards a spade, B must not think to place the lead in his hand by playing out king and another club; for Y will throw his queen on the king, leaving the command with Z, after which there is no way for AB to save the game.

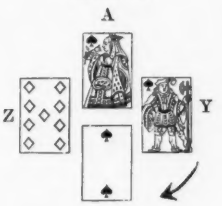
Trick 10.—It is, of course, necessary for B to dispose of his king of clubs before leading the spades.

Trick 11.



Tricks—AB, 6; YZ, 5.

Trick 12.



Tricks—AB, 7; YZ, 5.

Trick 13.—A makes the ace of spades, and AB score two by cards and win the game.

A's Hand.	B's Hand.
H.—10, 8, 5.	H.—Kg, 9, 7, 6, 3.
S.—Ace, Qn, 4, 3.	S.—10, 5, 2.
D.—Kg, 10, 4.	D.—8, 6.
C.—Ace, 8, 7.	C.—Kg, 9, 2.
Y's Hand.	**Z's Hand.**
H.—Kn, 4, 2.	H.—Ace, Qn.
S.—Kg, Kn, 9, 8, 6.	S.—7.
D.—2.	D.—Ace, Qn, Kn, 9, 7, 5, 3.
C.—Qn, 6, 4, 3.	C.—Kn, 10, 5.

In place of our usual elementary explanation of the play, we append an analysis of the play of B's hand and the inferences drawn by him from each trick.

Tricks.	Play.	Inferences.
1.	Plays highest card, third in hand.	A has exactly four spades; for, since B himself holds the two, the three cannot be a "penultimate." Z has eight and nine of spades, or no more. Either A has ace, queen, of spades and Y has king, knave, or *vice versâ*. In any other case, one or other of them would have played an honour.
2.	Leads trumps, holding five to an honour. Opens with penultimate to show number.	Z has no more trumps, or ace of trumps and no more; or he has ace, knave, and has played a false card. For, except in these cases, he would not put in his queen, second in hand, unless he also held the king; and the king is in B's own hand.
3 & 4.	Follows suit.	Z has led from ace, queen, knave, of diamonds and at least two others. Y being void, the remaining six diamonds must lie between A and Z; and A cannot have more than two, or he would have led diamonds originally instead of spades. Therefore Z must have at least four.
5.	Plays lowest card, second in hand.	Y may have four clubs, or he may be leading from a short suit in preference to returning the spades up to A. Since A wins the ten of clubs with the ace, YZ must hold queen and knave between them.
6.	Heads the trick. He might perhaps hold up the king, for Z cannot have anything but the ace, and if the ace had been with Y he would almost certainly have put it on the ten. But this course might leave A in doubt as to the position of the king, and nothing would be gained by it, as B retains the command with the nine.	The remaining trump may be with either A or Y; for A would in either case return the ten, and Y, holding knave, eight, might prefer to cover ten with knave. YZ are out by honours unless AB can forestall them by making two by cards.
7.	Trumps adverse winning card.	A has no more diamonds, and Z has the remaining four. Y's discard shows that Z has no more spades (see inference from trick 1), and therefore Z has two clubs.
8.	Draws the losing trump, its position being doubtful. If Y has it, and if B now goes on with clubs, either Y or Z will win the third round, and B, after being forced by a club or a diamond, as the case may be, will have eventually to lead up to Y's tenace in spades.	Y is evidently in a difficulty, assuming that the tenace in spades is against him. If he discards another spade, B will be able to lead spades, to which A will play his queen as the only chance of making game; Y, after winning with the king, must lead a club; B, winning with king in his turn, will lead another spade; and A will make his ace, and afterwards the small one.
9.	Accordingly, B leads another trump. The student will find that any other line of play loses the game, whether A finesses or not.	It is now certain that Y does not hold the major tenace in spades; with ace, queen, he would secure the game by discarding from that suit. He has clearly determined to leave the protection of the club suit to Z.
10.	Leads the best club. Otherwise Y, after getting in with a spade, would dispossess himself of the lead by continuing with the queen of clubs.	Z is left with the best club. Therefore the only way of winning the game is to lead a spade, trusting to A to pass it and remain with tenace over Y.
11.	Leads a spade accordingly.	

XUM

Chess Column.

By I. Gunsberg (Mephisto).

[Contributions of general interest to chess-players are invited. Mr. Gunsberg will be pleased to give his opinion on any matter submitted for his decision.]

NOTES ON THE HABANA MATCH.

The following table will show the course of play during the match:—

Game.	Opening.	Won by, as 1st player.	Won by, as 2nd player.	Drawn.
1.	Ponziani	T	—	—
2.	Spanish...	—	T	—
3.	French	—	G	—
4.	Four Knights	—	—	1
5.	Evans	—	G	—
6.	Two Knights Defence...	—	T	—
7.	French	—	—	1
8.	Zukertort	G	—	—
9.	Evans	—	G	—
10.	P—Q4	G	—	—
11.	Ponziani	T	—	—
12.	P—Q4	G	—	—
13.	Gambit declined ...	T	—	—
14.	Zukertort	G	—	—
15.	Centre Counter Gambit	—	—	1
16.	Dutch	—	T	—
17.	Vienna	—	—	1
18.	Dutch	—	T	—
19.	Spanish...	—	—	1
20.	,, ...	—	T	—
21.	,, ...	—	G	—
22.	Two Knights Defence...	—	T	—
23.	Centre Gambit... ...	—	G	—

The Attack won 7 times, the Defence 11 times.

Gunsberg was first player 11 times. With the move he won 4, drew 1, and lost 6.

Tschigorin had the move in 12 games. Of that number he won 3, drew 4, and lost 5.

Of 4 Ruy Lopez played (2 by each player), the second player won 3, and 1 was drawn. In two of these White played 4 P—Q4 without obtaining a satisfactory game. In the other two Black defended with 3 P—QR3, and White continued with 4 B—R4, Kt—B3, 5 P—Q3, P—Q3, &c., Black playing P—KKt3, B—Kt2, and Castles KR.

White in each case failed in sustaining an attack against the King's side.

There were six irregular openings. Four games were won by Gunsberg as first player, namely, two Zukertort and two P—Q4 openings; and two P—K3 openings played by Gunsberg were won by Tschigorin. From the play in these games it seems to follow that the defence should post the QB on QKt2, and endeavour to force the centre by P—K4, preceded by P—QB4, and the massing of pieces bearing on Black's K4th square.

Tschigorin won both the Two Knights Defences which he played. We think his success proves that the second player receives a good equivalent in position for the Pawn, but we can hardly say, in spite of the above success, that the defence is superior to the attack. In one of these games, after the usual moves, Gunsberg tried 8 B—Q3, instead of the customary move of 8 B—Q2, but lost much time in his subsequent play, thereby getting a bad game. We think the move feasible.

In the two Ponziani openings Gunsberg did not succeed in getting an even game by defending with 3 Kt—B3, which seems to speak in favour of the defence of 3 P—Q4.

Tschigorin lost two Evans Gambits, he playing 9 QKt—B3, to which Gunsberg replied with 9 B—KKt5 in one game, and Kt—QR4 in another. In both instances the defence proved valid.

The Vienna opening resulted in an inferior position for the first player, as follows:—1 P—K4, P—K4; 2 QKt—B3, KKt—B3; 3 P—B4, P—Q4; 4 BP × P, Kt × P; 5 Q—B3, Kt—B3; 6 B—QKt5, Kt × Kt; 7 KtP × Kt, P—QR3, &c.

In the French defence (Steinitz variation) Gunsberg re-took the QBP with the Knight, instead of with the B, *i.e.* 1 P—K4, P—K3; 2 P—Q4, P—Q4; 3 QKt—B3, KKt—B3; 4 P—K5, KKt—Q2; 5 P—B4, P—QB4; 6 P × P, QKt—B3; 7 B—Q3, Kt × BP, &c.

The Centre Gambit attack failed altogether, as the second player turned the tables completely as follows:—1 P—K4, P—K4; 2 P—Q4, P × P; 3 Q × P, QKt—B3; 4 Q—K3, Kt—B3; 5 QKt—B3, B—Kt5; 6 B—Q2, Castles; 7 Castles, R—Ksq; 8 P—B3, P—Q4, &c.

Finally, in the Gambit declined, the second player got a bad position by allowing White to advance the Gambit Pawn to B5, pin the KKt with the B on Kt5, and also post his QKt on Q5.

THE CLOSE OF THE SEASON.

With the opening of the month of April may be said to close the active season among chess-players. Outdoor amusements commence about this time of the year, and, as a consequence, attendance at the clubs begins to fall off. Among the hundred or more clubs that have been regularly meeting week by week during the last few months in London, there will not probably remain more than twenty or twenty-five in active work; and no doubt the same proportion of holiday recesses would be found to hold good were we to make a general tour of the country. Exceptions would, no doubt, be very few and far between, for in nearly every district we should find a cricket club or some attraction to lure away the young people who are regular attendants at the chess clubs.

In the case of older exponents of the game, chess, even in summer, forms still a suitable recreation to many who may be too tired after the work of the day to take part in out-door sport. It affords an opportunity for quietness and rest of body that no other amusement supplies, and, such being the case, it is no wonder that its practice is carried on by them more or less throughout the year.

At the present time there is no lack of material available for the ordinary student of chess, even though his club may be closed, and all his ordinary opponents scattered abroad in search of health and fresh air. There are so many chess columns running in the newspapers of the country that it would be almost impossible to find a corner where literature on the game was not easily obtainable; and it would be a great surprise to many who now regard the chess season as ending with the last days of March, to discover how eagerly these chess columns are perused in the quiet season, even by players who, on other occasions, hardly display any interest in them, because over the board practice is so ready to their hand.

There are, however, other indications to point to a season of activity in the chess world this year during the summer recess for clubs. In England we are looking forward to an International Chess Tournament at Manchester, when, with liberal prizes and the assurance of a hearty welcome, a large number of visitors are sure to be attracted. This will probably be the principal chess event of the next few months, although master contests are spoken of also in other parts of the world. Then we are promised a gathering at Cambridge, under the auspices of the Counties Chess Association, which is to be revived.

Looking back over the last few months we find much to occasion gratification to the chess-player. County associations have been started in various parts of the country, and have worked most successfully in advancing the knowledge of the game, while, as regards new clubs, it may fairly be said that the space at our disposal would not be sufficient to give even a summary of them. There is hardly a district in the kingdom that does not supply marked evidence of increased popularity for the royal game of chess and a general desire to make its practice more universal.

R. L. O'Beirne.—Berger's book on End-games is the best. In the position you sent we should not like to say for certain that White must win, but it seems so to us. Such endings are extremely difficult. White will of course play his King on a white square, and try and push his Pawns, *i.e.* 1 K—Q3, K—K3; 2 P—B4, B—Qsq; 3 K—B4, B—R5; 4 P—Q5, K—K4; 5 P—B6, B—Qsq; 6 K—B5, B—K2; 7 K—Kt 6, &c.; but there are many ways in which Black might get a chance of stopping the advance.

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